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ECO-INDUSTRIAL PARKS: A PROTOTYPICAL DESIGN APPROACH TO INDUSTRIAL LANDSCAPES

By

Erika F. Bowen

A thesis
submitted in partial fulfillment
of the requirements for the
Master of Science Degree
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College of Environmental Science and Forestry
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ABSTRACT

E. F. Bowen. Eco-Industrial Parks: A Prototypical Design Approach to Industrial Landscapes, 121 Pages, 23 Figures, 2020. APA style guide used.

This project will look at the role of industry in the rural landscape, the development of a promising new biotechnology initiative, the literature and case studies regarding eco-industrial parks, the specific principles of biophilic design (including techniques for protecting an endangered salamander), and a design for an eco-industrial park (in the Town of Riverhead, New York) that represents the applications of the examined principles, and an analysis of the design in terms of the three key characteristics.

Key Words: eco-industrial park

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INTRODUCTION

The purpose of this project is to explore the efficacy of re-developing an old industrial site into an eco-industrial park characterized by: (1) the use of renewable energy; (2) biophilic design leading to a forest bathing effect and the enhanced delivery of ecosystem services, and; (3) the ability to protect endangered species on site – and to do all three through a set of principles that are transferrable to a broad range of other re-development sites. This challenge is rampant across the rural/suburban post-industrial landscape of much of the eastern United States which has seen the decline of 19th century and 20th century industrial infrastructure and the prolific return of woodlands, wetlands, meadows, waterways, and wildlife.

PROBLEM DEFINITION

The New Forest Economy Initiative (NFEI) brings together the energy technology of a state-of-the-art biorefinery with the older idea of an eco-industrial park and the intentions of providing a transferrable concept for rural industrial development – one that would work in any forested region of the United States. There are, however, a number of unknowns. The biorefinery needs to be scaled up from a small, experimental model to one that is large enough to process 700 tons of wood matter per day. There are locational, architectural, landscape and logistical implications of a full-scale biorefinery that have yet to be documented and evaluated.

There are also a number of unknowns surrounding eco-industrial parks. When businesses, facilities planners, municipal officials, and design consultants refer to eco-industrial parks, they are not referring to any specific set of standards that address the conservation, preservation or enhancement of ecosystems, the delivery of ecosystem services, or the impacts of these on worker productivity, nearby property values, and citizen satisfaction.

The ecological, economic, social, and aesthetic impact of a wood-based biorefinery will add value to the site, to the nearby properties and bordering communities. The exact values are yet to be defined but the focus can be narrowed so that this study will quantify/qualify some of the above unknowns; more specifically:

- Ecosystem services including supporting services, provisioning services, regulating services, and cultural services
- Carbon sequestration and climate regulation both indoors and outdoors
- The sustainability of energy and fuel sources
- The carbon footprint of transportation methods such as rail and trucking to and from the site
- Cogeneration between eco-industrial park businesses and neighboring communities
- Increase in tax revenue and the increase of new jobs in the community
- Productivity in terms of employee response to forest bathing and therapeutic landscapes

In addition to the above, it is expected that the implementation of the New Forest Economy Initiative at the Enterprise Park at Calverton site in Riverhead, New York will spur the development of net zero industrial transportation systems, mitigation of the carbon footprint and other opportunities.

INTRODUCTION TO THE SITE

Located at the Eastern end of Long Island, in Riverhead, New York, is an industrial park called the Enterprise Park at Calverton or known as EPCAL. Once the home to Grumman, a company that manufactured Navy war planes, the Enterprise Park at Calverton site is an industrial park where businesses are reusing existing military buildings while the town's Community Development Association decides on a reuse strategy. The site is unique in the sense that it has several protected ecosystems coinciding with the industrial landscape.

PROJECT GOALS AND OBJECTIVES

The following goals and objectives were created during the initial research for this project. They serve as guidelines for research and for structuring the argument.

Goal: Develop a prototypical set of standards that can be reasonably referenced, applied, and presented to any rural community planning board and/or design team for the development of biorefinery powered eco-industrial parks

Objective: Explore the best practices for delivering ecosystem services, carbon sequestration, purification of stormwater, water dispersal, mitigation of carbon footprint, cogeneration, and forest bathing

Objective: Explore current guidelines of eco-industrial park development

Goal: Assist the New Forest Economy Initiative Team in the selection of appropriate sites, revitalization of struggling rural communities and effectively managing natural resources

Objective: Conduct site, community, and regional analysis of prospective sites for development

LITERATURE REVIEW

BOOKS

Bajpai, Pratima. *Biorefinery in the Pulp and Paper Industry*. Elsevier Science, 2013.

Biorefinery in the Pulp and Paper Industry is a book that details how the biorefinery concept works, biorefinery opportunities in the pulp and paper industry, biorefined product options, and future opportunities. The New Forest Economy Initiative is a concept that works well when repurposing defunct paper mill sites and this book discusses why paper mills sites are good places to establish a biorefinery and how you are able to produce different types of products based on a

site by site basis. The future opportunities that are discussed support eco practices such as fewer emissions and supports sustainable forestry with practices such as wood thinning, forestry residue, and urban wood waste. I used this information to influence my design decisions regarding the location of a wood-based biorefinery powered eco-industrial park. The location of an eco-industrial park powered by a wood-based biorefinery is important because there needs to be enough woody materials locally that can be harvested for the biorefinery. Defunct papermills are ideal sites because they are typically located in places that have an abundance of woody resources.

Li, Qing. *Forest Bathing: How Trees Can Help You Find Health and Happiness*. Viking, 2018.

In Dr. Qing Li's book, *Forest Bathing: How Trees Can Help You Find Health and Happiness*, he discusses the relationship between humans and forests, also known as "shinrin yoku" or forest bathing. Forest bathing is the act of immersing yourself in nature and the health benefits that arise when you do so. These practices can be integrated into design and applied in a workplace setting where employees are able to remove themselves from their day to day work environment and immerse themselves into nature thus increasing their productivity. Using the idea of forest bathing, I was able to design an eco-industrial park that was not only aesthetically pleasing, but it allows employees, visitors, and the community to use green space in ways that allows them to relax and decompress, remove themselves from their job or day to day stresses and immerse themselves in nature, exercise, and even provide outdoor meeting/teaching spaces. Employees will be more productive while at work and overall, have a happier well-being.

Thorbeck, Dewey. *Rural Design: A New Design Discipline*. Routledge, 2012.

This book talks about design principles and strategies that can be used when designing in rural communities. Since paper mills are primarily located in small communities where they are the

largest employer, I needed to learn how to approach designing a large-scale project in a small, rural community. After paper mills close, many families are forced to move to find work because rural communities are often-times unable to provide an abundance of jobs where people are able to make ends meet. When re-implementing a medium to large business in a small rural community, there will be a population increase that will need to be supported.

Exceptional Industrial Projects: Beyond the Box. National association of Industrial and Office Properties, 2003.

This book provides industrial park examples that demonstrate building layout and clusters, circulation and flow of large sites, and adaptive reuse of industrial buildings. I studied these projects throughout my design process to determine how to orientate and cluster buildings to maximize the greenest space and also to design a road network where large semi-trucks were able to travel seamlessly.

Arendt, Randall. *Rural by Design*. Routledge, 2019.

Rural by Design discusses design strategies and suggestions for rural communities and the qualities of traditional towns. It goes into detail about designing streets, travel corridors, and stormwater management. I considered all of these strategies during my design process to help design an eco-industrial park that fits into the community that surrounds it.

ARTICLES

N.a., "14 Patterns of Biophilic Design". *Terrapin Bright Green*, n.p., n.d., 10/20/2019.

The *14 Patterns of Biophilic Design* is an article that lays out the principles used in biophilic design and how they present a framework that relates to human biological sense and nature, a series of tools that help to understand biophilic design opportunities, and other considerations such as

user demographics, climate, etc. that would influence design decisions. The 14 patterns are classified into 3 categories; (1) Nature in Space, (2) Natural Analogs, and (3) Nature of Space that are meant to inform, guide and assist the design process. Each pattern considers how the pattern might impact the way a space feels, the relationship between human biology to nature and the built environment, highlights design attributes and considerations, and opportunities of integrative biophilic design strategies. These patterns are similar to the idea of industrial ecology where the built environment mimics naturally occurring processes in nature, examples; the natural flow of a body of water to a manmade flow of a body of water, terrain/soil/earth to highly designed landscapes, cloud movement to a choice of plantings that move or glisten with light breezes, solar heating/cooling gains transformed into heating/cooling in buildings, and the natural presence of water to constructed water features to name a few. All of these principles were able to help me tie together design parameters and the idea of creating an eco-industrial park that encourages forest bathing by mimicking natural processes into the built environment.

The Nature Conservancy. *The Pine Barrens of Southeast Massachusetts*, 2009.

The article *The Pine Barrens of Southeast Massachusetts* gives a good overall description of what the pine barrens habitat encompasses. The pine barrens are the habitat type that is currently present on the Enterprise Park at Calverton site and is the largest stand of pine barrens throughout Long Island. Since the habitat type is protected, preserving what is present on site is very important to not only the organisms that rely on the pine barrens, but it is essential for the concept of an eco-industrial park to be successful. I have used this article to reference species knowledge and to design parts of the site where the habitat will be re-introduced.

Town of Hinton, Alberta. *Inovista Eco-Industrial Park Development Guidelines*, December 2011.

The idea of eco-industrial parks surfaced in the early 1990's and are still a topic that is very underdeveloped. The town of Hinton in Alberta, Canada developed a set of development guidelines that they applied to an eco-industrial park that they were developing. The literature for designing and developing an eco-industrial park is very thin so finding a set of guidelines to use as a reference felt like discovering a gold mine. These guidelines start in the planning and development stage up to the construction, materials, and maintenance of an eco-industrial park. I was able to use these guidelines as a framework and customize them to the needs of an eco-industrial park that is powered by a wood-based biorefinery. The most important part of these guidelines is that they are general and designed on a system that requires you to meet a certain number of them to be considered an eco-industrial park. This allows these design parameters to be transferable to different types of sites with any type of design constraint or challenge, anywhere in the world.

VHB Engineering, Surveying, and Landscape Architecture, P.C. *Proposed Redevelopment of EPCAL Property at Calverton, July 2014.*

This article is a proposal that was prepared by a third party hired by the Town of Riverhead to provide guidance and feasible design solutions for the Enterprise Park at Calverton property. The firm completed a thorough site analysis where they evaluated existing ecological conditions, habitats, and identified rare/protected species and provided a habitat protection plan. They also provided a parcel map where they divided the property into smaller pieces of property that could be individually sold as residential or commercial properties for private development. I was able to reference this document for the information they provided on plants and animal species currently present on site and to do a comparison of their design strategy and my own. There was also a traffic study completed that determined the maximum amount of traffic that could travel

to the site at any given day and potentially what the traffic on site could be like. Overall, this piece was not only a great reference in terms of information about the site and what is found within the site, but it also gave me an example to compare traditional real estate/development and the newer idea of an eco-industrial park.

WEBSITES

“Boeing Long Acres Industrial Park.” PWP Landscape Architecture, pwpla.com/projects/boeing-longacres-park/&details.

Boeing Long Acres Industrial Park is a 212-acre site located near Seattle, Washington that was formally a racetrack. A multi-disciplinary team of professionals worked together to minimize the impact that development would have on site development. They specifically focused on restoring function to ecological systems. A key component in this design is water and restoring the natural flow of water on site through restoration of natural flow patterns and implementing new wetlands, a lake, streams, and a pond. They were also able to integrate permeable paths that were carefully designed to provide framed views of ecologically sensitive areas without encroaching on them. Currently present on the Enterprise Park at Calverton site is an endangered species of salamander habitat that is threatened through industrial pollution and encroachment. Boeing Long Acres Industrial Park demonstrated a way to restore and protect ecologically sensitive areas while being able to enjoy them aesthetically. Using this idea, I was able to propose the restoration of several wetlands and water bodies within the Enterprise Park at Calverton site and enhance the protection of the endangered salamander in similar ways that were done at Boeing Long Acres Industrial Park.

“Ford Rouge Center Landscape Master Plan.” William McDonough Partners, mcdonoughpartners.com/projects/ford-rouge-center-landscape-master-plan/.

The Ford Rouge Center located in Dearborn, Michigan was a restoration project of a manufacturing complex into a model of 21st Century industrial sustainability. With redevelopment in mind, the Ford Motor Co. realized that they had 50 million dollars in cleanup of toxic stormwater that had flown into the Rough River. William McDonough + Partners developed a master plan for the new development expansion of manufacturing facilities that integrated a new idea of stormwater management infrastructure within the landscape. Not only did they create a 100% functional landscape, they created a beautiful industrial park that sets the standard for eco-industrial park development. The “industrial strength” landscape connects buildings and site together through strategic design that masks the physical sites and stereotypes of what an industrial park looks like. I used this site as a case study because the designers were very successful in masking the views of a typical industrial park and indirectly incorporate industrial ecology and forest bathing into the site.

Georgesenic. “Eco-Industrial Parks & Industrial Ecology.” *Making Lewes*, 22 May 2014, makinglewes.org/2014/02/25/eco-industrial-parks-and-industrial-ecology/.

The eco-industrial park concept is based upon the idea of designing the flows of waste and energy into a group or cluster of buildings that all work together to harness their optimum use, the equivalent of an ecological system. There are three different types of eco-industrial parks that are outlined in this document that I dove into further depth to determine what type I wanted to use in creating an eco-industrial park at the Enterprise Park at Calverton. The three types of eco-industrial parks are (1) co-location or proximity, (2) shared byproducts, and (3) cleaner production.

New York State Department of Environmental Conservation. *Eastern Tiger Salamander Fact Sheet*. www.dec.ny.gov/animals/7143.html

The Eastern Tiger Salamander is an endangered salamander that is currently present on site.

These salamanders have a specific breeding ritual and require both wetlands and woodland to be able to mate. I used this information to effectively plan out controlled wetland areas and vernal pools with an adjacent woodland to give the salamanders optimal breeding habitat. When given a site with an endangered species present, an eco-industrial park is a great way to incorporate the needs of the endangered species and still able to allow businesses in proximity.

THE ENTERPRISE PARK AT CALVERTON SITE

The town of Riverhead is located along the North shore of Long Island, situated at the mouth of the Peconic River. The town serves as the county seat and encompasses 20,000 of the 35,000 acres of farmland that is on Long Island.

SITE HISTORY

In 1952, the U.S. Navy acquired 4,500 acres within the Town of Riverhead for construction of airfield runways and other associated facilities. At the time, the property was used mainly for farming and contained some residential development. It was chosen for its large size and its proximity to Bethpage in Nassau County where Grumman was already performing assembly of airplanes.

The 4,500 acres were leased to Grumman for airfield operations including final airplane assembly, while the remaining acreage of the site was designated as the aviation buffer zone; most of which was located in the Long Island Central Pine Barrens. Additional parcels were acquired over the years from individual property owners, increasing the Navy's holdings to over 6,000 acres. In 1976, approximately 900 acres of the northwest buffer zone north of Middle Country Road was transferred to the Veterans Administration for the construction of the Calverton National Cemetery.

Grumman leased the Calverton property for more than 40 years. In 1987, Grumman had approximately 23,000 employees on Long Island, including the employees at the Bethpage location. By 1994, that number declined to about 9,500 employees with 1,500 employed at Calverton. At that time, Grumman was still the largest employer in Riverhead and the annual tax revenues were \$1.5 million. By the middle of 1992, only one aircraft remained in production at Calverton. Calverton in Riverhead officially closed in February 1996.



FIGURE 1: AERIAL IMAGE OF THE ENTERPRISE PARK AT CALVERTON SITE IN RIVERHEAD, NEW YORK

In 1994, after Grumman's announcement of its intention to vacate the property, the United States Congress authorized the Secretary of the United States Navy to convey approximately 2,900 acres inside the fence to the town Community Development Agency (CDA) for economic development. Based upon this decision, the United States Navy addressed and evaluated the disposition and potential future of the Calverton property, a portion of which is included as part of the extant property now known as the Enterprise Park at Calverton (EPCAL) pictured above in *Figure 1*.

Reuse alternatives were then developed by the Planning Commission as authorized by the town CDA. The process of preparing these reuse scenarios began in 1995 and with extensive public input, preliminary plans were then presented to the Planning Commission for review. The Town Board unofficially chose the Calverton Enterprise Park Reuse Plan as the preferred reuse alternative. This plan included the development of the site with an industrial business park, theme park, aircraft and aviation, commercial, hotel and conference center, golf course and open space uses.

After the United States Navy's environmental review process, approximately 500 acres of the property were conveyed to a private developer for the development of Calverton Camelot. A separate environmental review was conducted for the development of the subdivision and development of Calverton Camelot began subsequent to that review and approval. Since 1998, there have been additional environmental development proposals on various portions of the original Calverton property, most of which have not proceeded.

With the contingency from the transfer of ownership, the Enterprise Park at Calverton property must be redeveloped into an entity that generates a tax base and provides jobs for the community thus leading the CDA to develop a comprehensive reuse strategy for the site.

A COMPREHENSIVE REUSE STRATEGY

Previously mentioned, in 1994, the ownership of the Enterprise Park at Calverton property was conveyed from the United States Navy to the Town CDA, except for acreage that had not yet been remediated of contamination found on the property. As part of the legislation transferring the property to the town CDA, it was required that the Town CDA formulated an economic development-based reuse strategy for the property.

The town of Riverhead proceeded to form the Calverton Air Facility Joint Planning and Redevelopment Commission, composed of various officials from the Town of Riverhead, surrounding towns, Suffolk County, New York State, the Federal Government, and civic organizations, to articulate a vision for the future reuse of the property. The Reuse Commission identified four primary goals for the reuse of the Enterprise Park at Calverton property which were:

- Attract private investment
- Increase the tax base
- Maximize job creation

- Enhance regional quality of life

To achieve these goals, the Reuse Commission envisioned an eight-part mission that included:

- To provide industrial land use in conformance with the Town of Riverhead Master Plan and amenities
- To provide a new zoning and use district regulating that will encourage the highest and best adaptive reuse of the property with the greatest potential for economic development while respecting the ecology of the area
- To encourage appropriate industrial and commercial development to accommodate regional growth influences
- To encourage specifically those types of industrial, commercial, and recreational uses which are integrated with the overall economic development policy of the Town of Riverhead
- To attract industrial development to an area which is economically and environmentally feasible for development due to existing infrastructure and other improvements
- To provide infrastructure improvements designed to mitigate against the degradation of the Peconic Estuary and the Central Suffolk Pine Barrens
- To examine continued aviation uses in support of on-site commercial/industrial development
- To identify and attract those enterprises and technologies which will generate employment of high skill levels, apprenticeship programs, and lower skill support employment to replace the economic activity previously existing at the site

Based on these goals and eight-part mission created by the Reuse Commission, a reuse strategy was developed. The 1996 reuse strategy included an Enterprise Park at Calverton master development plan for the subject property that was intended to create a marketable tool to attract private development.

The 1996 Reuse Strategy identified goals in redeveloping the Calverton property, developed a reuse strategy containing three phases, and established a Master Plan for the property. The Calverton master plan envisioned a multi-use enterprise park that has a major industrial complex as its focus but was intended to be flexible depending on the market and economic conditions.

The 1997 Environmental Impact Statement (EIS) discovered that, except for a conflict with the Peconic River Scenic Corridor, the Preferred Reuse Plan was consistent with applicable local, state, and federal requirements and regulations, assuming recommended mitigation measures were followed. The Peconic River Scenic Corridor that is regulated under the New York State Department of Environmental Conservation Wild, Scenic, Recreational Rivers program has approximately 530 acres of Calverton property that is located within the scenic corridor and prevents development. Under the Preferred Reuse Plan, this area was proposed to be developed. But, the 1997 EIS stated that the Pine Barrens Commission would support a re-delineation of the Peconic River Scenic Corridor boundary to allow for the development proposed under the Preferred Reuse Plan, only if the following conditions were met:

- Adhering to the Pine Barrens standards and guidelines through the adoption of a planned development district or a planned unit development that is consistent with the Pine Barrens habitat
- Incorporating plans for wastewater treatment plant improvements

Below is a list of identified unavoidable impacts associated with the Preferred Use Plan:

- Increases in vehicular traffic and substantial impacts at several study area intersections
- Reduction of potential habitat for certain wildlife species on the site

To achieve the goals outlined by the CDA, a renewal plan was created by the Town of Riverhead Urban Renewal Agency administered by the town CDA.

CALVERTON ENTERPRISE RENEWAL PLAN

The New York State Urban Renewal law was established to address areas that have characteristics such as:

- Deteriorated or deteriorating conditions to obsolete and dilapidated buildings and structures
- Physical deterioration of site and landscape
- Buildings abandoned or not substantially used
- Unsuitable topography, subsoil and other physical conditions all of which hamper or impede proper economic development of such areas and that impair or arrest sound growth and development of the area, community, or municipality

The New York State Urban Renewal Law further states that proper incentives be established in order to encourage development of areas in order to “eliminate slums and blight and to promote community growth and development in a manner consistent with the furtherance of the public welfare. It has also been found that it is necessary to encourage and stimulate private investment and the participation of owners and other responsible persons in sound and comprehensive programs of urban renewal for such areas.”

The Town of Riverhead established an Urban Renewal Agency in 1982, pursuant to the New York State Urban Renewal Law, which is administered by the Town CDA, to address areas within the town marked by such conditions. The Calverton Urban Removal Plan notes that the abandonment of the Calverton Property by Grumman has caused significant economic distress in the region and that redevelopment with appropriate manufacturing, industrial, and high-technology facilities is warranted given existing infrastructure.

The closure of the Calverton operation, at the time, resulted in the loss of approximately 4,000 jobs and \$1.1 million in tax revenues to the Town of Riverhead, Suffolk County, and the Riverhead Central School

District. The primary goals of such redevelopment would be to encourage job generation, generate tax revenue, and improve quality of life.

The primary aim of the Calverton Urban Renewal Plan is to achieve the following:

- The attraction of private investment in the site
- The maximization of the real property tax ratable base
- The maximization of skilled, high paying employment opportunities
- The protection of the natural environment and sustaining regional quality of life

The general goals of the Calverton Urban Renewal Plan are:

- To provide for industrial land use in conformance with the Town of Riverhead Master Plan and its amendments
- To create a regulatory environment that will encourage the highest and best adaptive reuse of the property with the greatest potential for economic development while respecting existing natural features and the local ecology
- To encourage appropriate industrial and commercial development to accommodate regional growth and influence
- To encourage the development of those industrial, commercial, and recreational land uses that integrate with the overall land use policy of the Town of Riverhead Board
- To attract industrial development to an area that is economically and environmentally feasible for development due to existing infrastructure and other improvements
- Extension and improvement of infrastructure within the Calverton Enterprise Park to support the reuse of existing buildings and new developments and to mitigate the degradation of the Peconic Estuary and the Central Suffolk Pine Barrens ecosystem

- Designation of up to 1,280 acres as an economic development zone pursuant to New York State Law to encourage development of the Calverton Enterprise Park to enhance the reuse and physical appearance of the facility
- Encouragement of development and rehabilitation of structures within the Calverton Enterprise Park to enhance the reuse and physical appearance of the facility
- Improvement and development of public facilities supporting new land uses consistent with the adopted plan

The Calverton Urban Renewal Plan addresses proposed land uses under the 1996 Reuse Strategy including an industrial business park, theme park district, sports park, and open space area.

THE NEW RURAL PLANNING AND DESIGN

Rural design addresses the interaction between science and society to improve the quality of life in rural communities. As a new and evolving design discipline, rural design can be used to help communities revitalize assets that once made them thrive. The fundamentals of rural design help to establish community design guidelines that helps planners and designers understand the unique characteristics of rural landscapes and ecosystems where infrastructure is a component of the landscape.

A NEW WAY OF DESIGN THINKING (RURALISM)

The idea of ruralism focuses on the preservation or the enhancement of rural communities in a process that improves quality of life and economic well-being. These communities are relatively unpopulated areas that are rich in natural resources.

Rural design provides a solid foundation and encourages new design thinking in which human and natural systems are holistically connected. Dynamic and continuous solutions are reached through a collaborative problem-solving process often orchestrated through town and county planning departments. As a strategy, rural design uses research and new ways of thinking to address problems in rural regions. The principles and methodologies are widely adaptable and can be used anywhere because rural design, by definition, is rooted in nature and culture of the place.

The characteristics of rural landscapes are usually the targets of rural design and development guidelines. These guidelines usually contained in rural comprehensive plans are aimed at protecting assets such as forests, meadows, wetlands, waterways, wildlife and arable land. Ideally these guidelines try to simultaneously advance economic development and rural asset protection.

Rural design can be defined as the spatial arrangement of rural landscapes and the civil infrastructure within them. It is about using design as a problem-solving process in rural regions to nurture human ingenuity, entrepreneurship, creativity, and innovation. This leads one to think that buildings and structures in rural towns are added objects within the larger, open landscape. Rural character and defined rural places have scales and relationships to the natural and altered environments that requires rural designers to understand the cultural and natural landscape in the region in which they are working.

The issues that are impacting rural regions throughout the United States are broad and complex. Communities are suffering from demographic shifts, loss of population density, lack of jobs for younger generations, and limited access to quality communication, education and health services. Social conflicts that are bringing concerns about sustainability, the scale of farms, and agricultural practices and methods all contribute to the concerns.

Cultural landscapes entail dynamic physical properties. There are links between societies and environments that represent the combined works of nature and humankind. Perceptions of the environment and its values, institutions, technology, and political interests drive variations in planning and management goals. Citizens are often unaware of their community's assets and rural design provides an engagement opportunity to reveal these assets. Rural design principles are not structured to impose a vision or solution in a community, but to:

- Provide guidance, information, tools, and support that rural communities need to address their issues
- Help the citizens in rural communities manage changes caused by economic, environmental, or cultural reasons
- Assist in creating a synergy for environmental wellbeing, rural prosperity, and quality of life and

- To help citizens of the community visualize and achieve quality solutions for the future of their rural community

In many cases, rural communities were developed in a time when designers and planners were non-existent and knowledge pertaining to the importance of sensitive environmental systems was lacking. These communities were developed during a time when recreation considerations were not of cultural importance. Communities that were developed with little regard to wetlands and natural drainage problems missed the opportunity of conservation and to highlight those ecosystems as focal points. These ecosystems could have been used in the creation of linear park systems that could have enhanced the quality of life for nearby residents and benefit the integrity of the ecosystem.

This new way of community design thinking is beneficial because it engages members of the community, increases economic vitality, fosters human and environmental health benefits, and revitalizes the sense of the community. This new way of thinking allows designers and planners to fully immerse themselves to help understand the functions of small, rural communities so that they can provide the best advice and guidance to that specific community.

ROLE IN RURAL DEVELOPMENT

Due to the location in rural communities and taking over a range of defunct industrial architecture, principles of rural development should be mentioned. The nature of rural place is characterized by a living, evolving, low-density working landscape that includes human settlements (county, town village, or hamlet), large-scale natural features and systems (forests, wetlands, waterways, meadows) and large-scale managed productive parcels of land (farms). Because of the low-density settlements there is a low-density of interaction among humans, compared to the high levels of interactions that takes place in cities.

Rural community boundaries are determined by political delineation and sometimes by geographical features. The type of community; town, village, or hamlet is determined by the population threshold and

the amenities that are available to the people who reside there. Each community type has specific qualifications and requirements relevant to its classification.

Towns in New York State are municipal corporations and serve as the major divisions of each county. Divisions are classified by the United States Census Bureau under minor civil divisions meaning that the primary government or administration districts are the determining boundary factors. Towns are responsible for the arrangement of primary functions of local governments and providing municipal services for their residents. New York State has 62 counties that encompass 932 towns that never cross the boundary lines to neighboring counties. A town can contain one or more villages having clearly defined legal boundaries. Hamlets are unincorporated settlements dependent upon town government.

Counties provide municipal services for its residents and address all municipal needs, that are not addressed by smaller municipal entities such as towns, villages, and hamlets. Each of the smaller types of municipalities provide services to the citizens not available from smaller entities. Hamlets are unincorporated, meaning without government and its services are provided by the county, town or both. To be more specific, villages are incorporated areas that are classified by the United States Census Bureau as having legally prescribed limits, powers, and functions. A village is a municipality that provides services to its residents that may or may not include; garbage collection, cemetery management, street and highway maintenance, street lighting, building codes, law enforcement and other municipal services. To be an incorporated village, the population threshold must be at a minimum of 500 people and cannot be larger than 5 square miles unless the boundaries are coterminous with a school, fire, or law enforcement jurisdiction.

Another type of settlement jurisdiction that is apparent throughout New York State is called a hamlet. The term hamlet is not defined under New York State law, but it is often referred to as an unincorporated community encompassed within a town. Hamlets do not have governments of their own and depend upon the town government for municipal services. They usually have corresponding names of the local school district, post office, or fire district and the New York State Department of Transportation (NYSDOT) uses signage along roadways to mark where hamlet boundaries are.

Throughout every rural settlement whether it be towns, villages, or hamlets, common characteristics repeatedly appear. Depending on location and governance of the settlement, these attributes help to visually characterize that area as rural. Visible components include but are not limited to:

- Topography and natural elements of a specific geographic location; forests, meadows, waterways, lakes and ponds, and wildlife
- Towns, villages, and hamlets with accompanying infrastructure; various building types in governmental, institutional, and educational sectors, public works, roads (1 ½ - 4 lanes), recreational facilities and accompanying space, and residential neighborhoods
- Farms and accompanying buildings and equipment; out buildings, herds of livestock and required acreage for grazing, fields of crops
- Energy infrastructure; dams, reservoirs, turbine and solar arrays, power stations, and transmission lines
- Recreational facilities; mixed resorts, boat launches and boat yards, hiking trails, and off-road utility vehicle trails

Topography and natural elements of a specific geographic location are often determined regarding the location of human settlements. Features that provide an abundance of natural resources and good land for

agricultural purposes make ideal places for people to make their homes. In the Northeastern United States, the climate is considered temperate and supports deciduous forests that is the best land for agriculture. Rural farming is greater where deciduous forests are most apparent, compared to evergreen forests which usually means the soil is sandy, too wet, or the growing season is too short and therefore unsuitable for crop production.

THE NEW FOREST ECONOMY INITIATIVE

The New Forest Economy Initiative (NFEI) is an integrated set of business clusters that targets a complex set of economic development and environmental issues that will benefit all of New York State's rural regions. The rural forest products industry in New York State (and the nation) has been decreasing for many years and is continuing to contract because of many internal and external influences. This contraction is causing large impacts on rural industrial bases, infrastructure and tax bases.

In *Figure 2* below, the concept of The New Forest Economy Initiative is broken down into Agricultural and Forest Industries and Environment Stewardship Component, Site and Strategy Selection, and Implementation Components. The first component, Agricultural and Forest Industries and Environment Stewardship Component, talks about the availability of timber and biomass resources which ultimately leads into the second component of Site and Strategy selection where the selection of the site depends on the availability of natural timber and biomass resources. The third component, Implementation, discusses the biorefining process, what is the result of the process, and how those extracted materials can potentially be derived into other products.

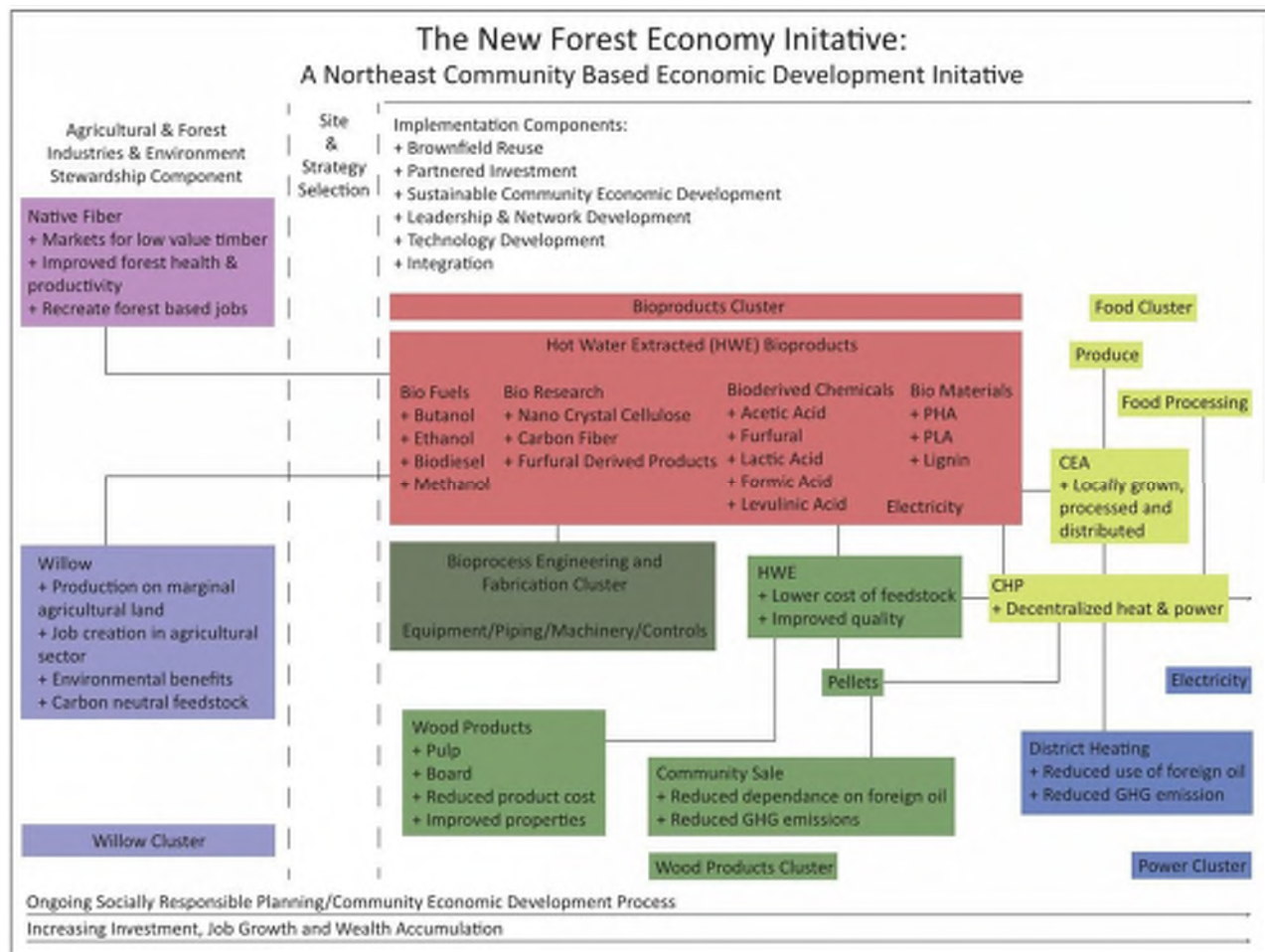


FIGURE 2: THE NEW FOREST ECONOMY INITIATIVE

In addition, as the industry contracts, new uses are emerging for the states forest fiber; such as biomass electricity and heat. The shrinking forest product base and the resulting increased use of forest resources for biomass is raising concern about forest stewardship and the future economies of forest embedded communities and regions.

According to the Pulp and Paperworkers Resource Council there have been 1,853 paper mill closures across the United States since 1990 due to changes in technology, age of facilities, global economy, and high energy costs. In 1998, there were 56 pulp and paper manufacturers in New York State and in 2013, 38 of those mills remained. With paper mills closing, defunct architecture is left to deteriorate and cause an

aesthetic and financial burden in the community. Biorefinery technology has the ability to repurpose pulp and paper infrastructure into a new profitable process.

BIOREFINERY TECHNOLOGY

The New Forest Economy Initiative aims to regenerate industries, communities, and regions, by bringing together the energy technology of a state-of-the-art biorefinery and other environmentally enhancing technologies.

THE *ABS PROCESS™*

In the centuries of evolution leading up to today's societies, humans primarily lived in an agrarian society where food and fuel was grown for consumption and everyday use. Since today's world population is significantly larger and is more settled in urban or suburban areas, it is impractical for most people to produce their own food and fuel. As with many products, food and fuel are provided through economically viable, industrial manufacturing and supply chains. As a part of that chain, the biorefinery is a manufacturing facility that transforms raw plant biomass into products for human use.

The *ABS Process™* (*Applied Biorefinery Process™*) is a commercially deployable, economically viable, biorefinery sequence that encompasses steps from the pre-treatment of lignocellulosic raw materials through purification and preparation of multiple materials for commercial sale. Lignocellulosic raw materials can be described as dry, woody matter that is the most abundant available raw material on the Earth that can be used for the production of biofuels. The *ABS Process™* subsystems include screening and cleaning of incoming raw plant biomass, followed by a *Hot Water Extraction™* technique, and numerous steps to separate, recover, and concentrate output products for sale and transport.

HOT WATER EXTRACTION™ PROCESS

The *ABS Process™* can be described as the extraction of useful biochemicals from non-food plant biomass, with a *Hot Water Extraction™* technique. The process, diagrammed above, is carried out by contacting a charge of non-food plant biomass material with water in a pressurized vessel at an elevated temperature. After the extraction takes place, the extract solution contains a mixture of chemicals such as; sugars, acetic acid, methanol, formic acid, furfural, and lignin. In the mixture, these chemicals are not useful, so the extract must be further processed to purify and concentrate the components. Once separated, inhibitory chemicals such as acetic acid, lignin, and furfural can be recovered as commercial chemicals. The left over woody or fibrous solids are a significantly improved raw material that can be used for the manufacturing of pulp and paper, fuel pellets, fiberboard, and other wood products with a higher resistance to absorption of moisture.

A biorefinery should be designed with processes that extract as much high value product from raw materials as possible. From a manufacturing standpoint, economic viability is enhanced through efficiency; reducing production costs and capturing all of the potential product value from a raw material.

BY-PRODUCT DEVELOPMENT

Many conventional wood-derived products can be improved when produced from woody biomass subjected to the *HWE™*. Following the *HWE™* process, the residual woody material contains predominately cellulose; an excellent biopolymer of wide applications, and lignin; an aromatic polymer with a wide range of valuable commercial applications. The following are examples of the benefits of *HWE™*:

1. “Pulp and paper: Following the removal of most hemicellulose related compounds through *HWE™*, residual sugar maple chips are reduced in mass typically by 23%. These *HWE Advantaged™* chips, with reduced hemicellulose content, higher porosity (lower density), and with lignin of higher

reactivity and weaker LCC, can improve pulping and bleaching, improve net energy efficiencies, and can offer lower chemical use, increased pulp viscosity, as well as higher bulk, absorbance, and stiffness of pulp. A lower tensile strength inherent to the paper made from this type of pulp can be increased using a conventional dry strength agent, starch, or recently evaluated polylactic acid as a potential product of a biorefinery based on lignocellulosics.

2. Fuel Pellets: ABS research on fuel pellets produced from *HWE Advantaged™* woody materials showed that these pellets have: 1) reduced ash content; 2) increased Btu/lb. content; 3) increased hydro stability; 4) increased physical durability. HWE-induced ash reduction (property #1) is well documented, and properties 2, 3, and 4 are consistent with higher relative lignin and lower hemicellulose contents. All these improved properties combine to create superior fuel pellets.
3. Fiberboard: Decreased woodchip bulk density (after hot-water extraction) leads to lighter products, and reduced hemicellulose content leads to decreased hydrophilicity, increased weather resistance, increased dimensional stability, and an expected increase in mold resistance. This could be a significantly improved material for reconstituted wood products. A project is underway in collaboration between SUNY ESF and Washington State University to quantify the gains.
4. Carboxymethylated Cellulose: Hot-water pre-extraction of wood significantly enhanced the reactivity of the cellulose component in the residual woody material and could facilitate the preparation of the carboxymethylcellulose (CMC) as the bulk of hemicelluloses are removed.
5. Nanocellulose: Nanocellulose is a high-value product that can be obtained by acid hydrolysis of cellulose. Removal of hemicellulose material through *HWE™* makes the residual lignocellulosic material more chemically reactive and amenable to delignification. In addition, the increased relative cellulose content along with more accessible regions of amorphous cellulose, in combination, are expected to improve the recovery rate of nanocellulose.

6. Sugar from Cellulose – Glucose: As mentioned above, lignocellulosic materials are more chemically reactive following *HWE™*, and they are therefore more amenable to hydrolysis by biochemical or thermochemical pathways. Research is underway to test the economic viability of depolymerizing residual amorphous cellulose from hot-water-extracted cellulose material into fermentable glucose as a coproduct with nanocellulose production.”

Chapter 7: Niche Position and Opportunities for Woody Biomass Conversion, Thomas E. Amidon, Biljana Bujanovic, Shijie Liy, Asif Hasan, and Joel R. Howard

An increased value can be generated by isolating relatively pure substances from heterogenous raw materials. Biorefinery technology is part of the future of eco-industrial parks.

ECO-INDUSTRIAL PARKS

Eco-industrial parks are industrial parks where businesses work together to share resources, minimize waste and pollution, and increase the quality of the environment. The concept behind eco-industrial parks comes from a process called industrial ecology where the built world mimics processes that occur in the natural world.

INDUSTRIAL ECOLOGY

Since the Industrial Revolution, the increase in global development and living standards associated with industrial activity, has had serious environmental impacts around the world. Industry takes in a lot of material flows from nature, often exceeding nature's reproduction rate, therefore leaving a risk of natural resource depletion. Natural resources are not used as efficiently and thoroughly as they can be in industrial processes leaving an efficiency gap of wastes, losses, pollution, degradation, and increased environmental costs. Since there are physical limitations that nature poses upon industrial development, ecosystem material flows can be used for the prescription of the overall goal and vision for sustainable industrial ecosystems. Industrial ecology provides the technological and scientific basis for achieving sustainable industrial ecosystems and is a step towards global sustainability.

Industrial ecology is the study of the flow of materials and energy in industrial and consumer activities, the effect of these flows on the environment, and the influences of economic, political, regulatory and social factors on the flow, use and transformation of resources. Industrial ecology aims toward the shift from industrial systems to industrial ecosystems in complete cyclicity (the quality or state of something that occurs or moves in cycles) in material and energy flow. Ecology is used as a metaphor due to the observation that natural systems reuse materials and have a largely closed loop cycling of nutrients. Ecological systems put emphasis on the throughput of materials and on the interactions and interdependence related to the stability of the systems. Some key principles of industrial ecosystems are:

- Industrial activity should reduce the amount of natural resources that industry takes in from nature
- The amount of non-harmful flows of nutrients that are returned to nature should be increased
- The use and re-use of materials should mimic natural systems

Industrial ecology is dependent on natural resources and services provided by the biosphere just as human systems are dependent on technology. It can concentrate on products and materials or it can have a regional ecosystem approach that uses tools like material flow analysis including substance flow analysis, life cycle analysis and design for environment. A more localized approach is the study of eco-industrial parks.

Many eco-industrial parks are developed with an industrial ecology concept called a by-product exchange. A by-product exchange is a planned system for trading material, energy, and water by-products between companies within an eco-industrial park, a nearby community, and/or a region. Companies involved in a by-product exchange are expected to use discarded resources rather than wasting them, to reduce pollution, to cut disposal costs, to gain new revenues, and strengthen business relationships. This leads us to a vast menu of opportunities that are presented when developing an eco-industrial park.

TYPES OF ECO-INDUSTRIAL PARKS

An eco-industrial park *“is a community of manufacturing and service businesses seeking enhanced environmental and economic performances through collaboration in managing environmental and resource issues including energy, water, materials ...the community of businesses seeks a collective benefit that is greater than the sum of the individual benefits each company would realize if it optimized individual performances.”*

Lowe & Warren 1996

By working together, the community of businesses seek a collective benefit that is greater than the sum of individual benefits of each company. Businesses seek enhanced environmental, economic, and social performance through the management of environmental and resource issues. The goal of an eco-industrial park is to improve the economic performance of participating companies while minimizing their environmental impacts. Eco-industrial parks are generally comprised of three core elements:

- Recycling businesses
- Environmental technology companies
- Businesses based around a single environmental theme – I.E. Biorefinery

Typically, these elements are included in the design of an eco-industrial park, but the vision for an eco-industrial park is far more complex. In order for an area to be considered an eco-industrial park, real waste or energy exchanges must occur between organizations. Physical settings may also vary in situations ranging from reclaimed brownfields to developing green fields and they can be based on manufacturing, agricultural products, fisheries products, or forestry development. All eco-industrial parks should plan to provide a scenic landscape and other recreational uses in addition to economic use. An eco-industrial park demonstrates clear patterns of development, ownership, property definition, and jurisdictions that are responsible for management, maintenance and control.

Eco-industrial development can be driven by a community, a local government, a non-profit organization, or by a business. Whichever the model driver may be, participants generally agree that eco-industrial development requires broad support and will benefit from collaborative strategies. We can classify eco-industrial parks into 3 different types according to their geographic location and quality of exchanges:

1. Co-location or proximity: A variety of companies which are clustered near resources and recycling facilities

2. Shared byproducts: Companies use waste energy from other companies as inputs in their own processes
3. Cleaner production: An emphasis on cleaner production throughout the production process

There are a handful of issues that need to be considered when designing an eco-industrial park:

- o Natural Systems - An eco-industrial park can fit into a natural setting in a way that minimizes environmental impacts while cutting operational costs. By enhancing the natural ecosystem that is currently present, landscape maintenance will be minimized, stormwater purification will take place, and it will provide climate protection for the building. Design choices in types of materials, infrastructure, and building equipment, park design, and landscaping can reduce an eco-industrial park's consumption of renewable resources.
- o Energy - The efficient use of energy is a major strategy for cutting costs and reducing burden on the environment. The implementation of greater efficiency in individual building, lighting, and equipment design minimizes costs to individual companies and the eco-industrial park as a whole. District heating can be used as an example: flows of steam or heated water from one company to another can be incorporated as a heat source. In many cases, the eco-industrial park infrastructure can be organized in a way that renewable energy sources such as wind and solar energy are utilized.
- o Material Flows - In an eco-industrial park, companies see wastes as products they have not figured out how to re-use internally or market to someone else. Individually and as a community, researchers work to optimize the use of all materials and to minimize the use of toxic materials. The eco-industrial park infrastructure may include the means for moving by-products from one plant to another, warehousing by-products for shipment to external customers, and common toxic waste processing facilities. Companies in an eco-industrial park may enter regional exchanges as well.

- Water Flows - In individual companies, architects specify high efficiency building and process equipment because process water from one plant may be re-used by another plant, passing through a treatment plant if needed. Eco-industrial park infrastructure may include mains for several grades of water, depending on the needs of companies, and methods for collecting and using storm-water runoff.
- Park Management and Support Services - As a community of companies, an eco-industrial park needs a sophisticated management/administrative system. The administrative department maintains links into regional by-product exchanges, site-wide telecommunications, marketing, park maintenance and control, and the management of existing and perspective tenants. An eco-industrial park may also include shared support services such as a training center, cafeteria, child and elderly day care center, office for purchasing common supplies, and transportation.
- Sustainable Design and Construction - Eco-industrial park's design and planning teams design buildings and infrastructure to optimize the efficient use of resources and to minimize pollution. Planners seek to minimize ecosystem impacts by careful site preparation and environmentally sensitive construction practices. An eco-industrial park is designed to be durable, maintainable, and readily reconfigured to adapt to change. At the end of a companies' lifespan, materials and systems need to be easily re-used or recycled or adaptable for what is yet to come.
- Integration into the Host Community – Eco-industrial parks that have neighboring communities should take advantage of the many opportunities presented by government services, educational systems, housing, etc. The project will be able to return value to the community through such institutions as a business incubator to support new businesses or expansion of existing ones in the community. Some may become tenants and others may provide essential services or supplies to tenants. The integration of training programs can help to build a stronger workforce in the community and strengthen the local community. A major return from this collaborative approach

is the potential formation of a public/private partnership to assume financing of some aspects of the eco-industrial park.

An eco-industrial park must develop an industrial ecosystem that reflects the linkage among the community's natural resources, existing and potential businesses, transportation infrastructure, and material flows throughout the local and regional economy. Perspective tenants need to be compatible with the goals of the eco-industrial park and community and there needs to be incentives for existing businesses to remain. The variety of businesses needed for an eco-industrial park to function successfully ranges from small businesses and incubator companies to local enterprises, environmental technology firms, and larger corporations.

ECO-INDUSTRIAL PARK MANAGEMENT

During the decision-making process, management in eco-industrial development needs to enhance mutual or collective benefits of stake holders within the park, including the biophysical environment.

ADMINISTRATIVE FUNCTIONS

Eco-industrial parks are communities of companies with challenging management and support systems. Administrative duties include standard maintenance functions and recruitment. In the planning phase, the administrative team should find new connections between companies and look for value adding functions. Administration should cooperate actively with the community and encourage dialogue between interest groups. There needs to be a collective decision about which services the park management provides and which are brought from public utilities, external contractors or done by the company itself.

FINANCING

One very important aspect that needs to be heavily considered while developing an eco-industrial park is financing. Private financing is critical to build projects beyond start-up models and for eco-industrial parks

to become a common approach for economic development. Private financing may be difficult to obtain since financial institutions are not familiar with the potential of eco-industrial parks to lower risk and increase rates of return. Institutionalizing eco-industrial parks as a new paradigm for economic development will require:

- Financing that can be provided by private sector financial markets
- Development that can be done by firms now viewed as conventional developers
- Business profits that are comparable to, if not greater than, traditional business investments

Since this will take some time to accomplish, governments, communities, and progressive businesses have an important role in helping launch, pilot, and nurture eco-industrial development so it can eventually be financed and managed through market mechanisms.

PERFORMANCE STANDARDS

Performance standards need to be developed and agreed upon during the planning and design of an eco-industrial park. Standards will vary based upon the type of eco-industrial park, the overall goal of the facility, and location. Some environmental regulations discourage businesses from co-locating or partnering with one another. Removing physical barriers to waste exchanges at a site or region were two issues that were specifically identified.

Once proven, businesses can improve performance and save money by locating to an eco-industrial park. The belief is based on the promise of synergies, economies of scale, and potential reductions in risk and liability offered by eco-industrial parks. Communication between administration and businesses should occur regularly and the exchange of information made easy and seamless. Participants need to agree that sharing challenges, strategies and successes are critical to further progress.

SUPPORTING MATERIAL AND ENERGY EXCHANGES

Supporting and maintaining the exchanges of materials and energy among companies are important aspects in an eco-industrial park. This represents the relationships between businesses that relate to the industrial ecology concept. Administration or a third party, sometimes a coordinator, enhances the flow of exchanges between the companies in the park. Management maintains the diversity of the companies and the compatibility of by-products as companies change over time.

One of the main jobs of the administrative team in an eco-industrial park is to support improvement in the environmental performance of individual companies and the park as a whole. The administrative team supports an information system to enhance inter-company communications, to inform members of the state of their local environment, and to provide feedback on the eco-industrial park's performance. Also, management should develop efficient marketing strategies and techniques and keep up to date on legislation and regulations. The park can also maintain shared support services such as a training center, cafeteria, adult/child day care center, stores to purchase general supplies, and transportation.

BENEFITS OF ECO-INDUSTRIAL PARK DEVELOPMENT

Communities embracing the eco-industrial park concept are seeking benefits for all public and private stakeholders. These benefits include:

- Business derives cost savings and new revenues, shared services, reduced regulatory burden, and increased competitiveness.
- The community enjoys a cleaner, healthier environment, business development and job creation, an attraction for new employees, and a positive impact on the economy and the environment.
- Government receives increased tax revenues, reduced enforcement burden, reduced costs of environmental and health damage, and reduced demand on municipal infrastructure.

- For the environment, there is reduced demand on finite resources, decreased local and global pollution, enhanced environmental health, increased use of renewable energy and materials, and an overall renewal of natural systems.

BENEFITS TO INDUSTRY

For the companies involved, an eco-industrial park offers the opportunity to decrease production costs through increased materials and energy efficiency, waste recycling, and elimination of practices that incur regulatory penalties. Increased efficiency will also enable park businesses to produce more competitive products. Some common business services such as shared waste management, training, purchasing, emergency management teams, environmental information systems, etc. can be shared among firms in an eco-industrial park. Industrial cost sharing could help businesses achieve greater economic efficiency through their collaborations.

These benefits for participating companies are likely to increase the value of property for private or public real estate developers. The services generate new revenues for park management companies. Eco-industrial parks may gain a competitive advantage, an especially important benefit in a time when there is over-capacity in industrial markets.

BENEFITS TO THE ENVIRONMENT

Eco-industrial parks will reduce many sources of pollution and waste, as well as decrease demand for natural resources. Park tenants will reduce their environmental burden through more innovative approaches to cleaner production that include pollution prevention, energy efficiency, water management, and resource recovery. The siting, infrastructure, and recruitment of an eco-industrial park will be determined by local carrying capacity and ecological characteristics of the site. The enhancement of the natural habitat and biophilic design practices will provide positive environmental impacts. Every eco-

industrial park will serve as a working model for park developers and managers to learn how to improve their bottom line while meeting high environmental and social standards.

BENEFITS TO SOCIETY

The economic performance of participating businesses within an eco-industrial park, will make a powerful economic development tool for communities. Such parks will attract leading-edge corporations and open niches for new or expanded local ventures. Both will create new high paying jobs in much cleaner, state-of-the-art facilities that help in re-establishing the middle-class. Companies within the region will gain new clients for services and buyers for products in the new firms in an eco-industrial park. The development of eco-industrial parks will create programs for extending economic and environmental benefits across a community's whole industrial sector. Not only will an eco-industrial park contribute to the financial well-being of a region, it will contribute to the environmental well-being as well. Through biophilic design and the implications of ecosystem services and forest bathing design techniques, an eco-industrial park is a place that enhances the encompassing ecosystem and an increase in productivity in the employees who work there. An eco-industrial park is a concept that will counter current perceptions of industrial company's aesthetics and will break down barriers between industrial sectors and communities by promising cleaner air, land, and water, major reductions in waste, and a more attractive work and recreational environment.

CHALLENGES OF ECO-INDUSTRIAL PARK DEVELOPMENT

The concept of eco-industrial parks is rooted in industrial ecology. With growing and expanding urban centers, the opportunities of eco-industrial park development are high. The challenges in research and development would include survey and documentation of existing industrial and service systems, assessment of possible convergence areas and awareness of the benefits of eco-industrial parks.

The development of an eco-industrial park is a complex undertaking and demands integration across many fields of design and decision making. Success depends on a new level of collaboration among public

agencies, design professions, project contractors, and companies locating within the park. The possible inability to overcome traditional fragmentation within and between these groups is a major risk.

Some benefits of eco-industrial park development may only become apparent when costs and savings are calculated in a longer time frame than is typical in industrial park financing. Developers will need to make a strong case for banks to finance a project with a longer payback period, such as inclusion of renewable energy for critical backup power. On the other hand, some options for infrastructure may cost less to build and maintain.

The development of some eco-industrial parks may cost more than traditional parks, depending on the design choices in the project. Added costs could come from the design process, site preparation, infrastructure features, construction processes, building material choices, and aspects of state-of-the-art building design. The additional costs may or may not be offset by savings in operating the park as an eco-industrial park, given the payback period acceptable by the developer. Public development authorities may be better prepared to bear this possible increase in development costs than private developers or the public sector may fund some aspects of the development with strong public benefits.

Companies that use each other's residual products as inputs in a by-product exchange face the risk of losing a critical supply or market if a plant closes. To some extent, this can be managed as with any supplier or customer relationship, by always keeping alternatives in mind and writing contracts that insure reliability of supply. The exchange of by-products could lock in continued reliance on toxic materials. Cleaner production solutions of materials or process redesign should take priority over trading toxics within an eco-industrial park.

Some companies are not experienced with working in a community and may fear the interdependence that is created while being a tenant of an eco-industrial park. Collaboration may be particularly difficult if your

eco-industrial park includes companies from many different countries and cultures. On the other hand, many large and small companies see such interdependence as a major source of competitive advantage.

THE ECO-INDUSTRIAL PARK IN RURAL PLANNING

In a lot of scenarios, industrial parks are located in rural communities. To redevelop an existing industrial complex, repurpose defunct industrial architecture, or implement a new eco-industrial park in a rural community, the strategies of rural planning need to be explored. The following case studies reveal those strategies.

ECO-INDUSTRIAL PARK CASE STUDIES

The initial biorefinery processes were created at a micro scale where small samples were tested. To continue the sample testing, a medium sized scale-up facility needs to be constructed to produce larger quantities of samples to measure the feasibility of a larger biorefinery. The development team that consisted of professionals from the Landscape Architecture Department and Bioprocess Engineering Department began studies on small, rural communities in New York State that have the ideal conditions to build a scale-up biorefinery model. The list of rural community qualifications included:

- Loss of population
- Loss of a major business/corporation that provided economic vitality and a large percentage of jobs in the area
- Gentrification shift; younger generations that move away for better job/living opportunities

While the State University of New York College of Environmental Science and Forestry (SUNY-ESF) Department of Bioprocess Engineering was testing the biorefinery, the SUNY-ESF Department of Landscape Architecture was advocating for eco-industrial parks in the Adirondacks that would be powered by wood-based biorefineries. One such exercise was a study done for the village and town of Tupper Lake, New York.

OVAL WOOD DISH FACTORY, TUPPER LAKE, NEW YORK

Tupper Lake, New York is a village located in the heart of the Adirondack Park. The Tupper Lake Economic Development Strategy of 2007 recommends that the community “focus on business retention and business attraction in a private sector industry other than tourism.” It also recommends that the community brands Tupper Lake as a center for environmental and natural sciences education. The town planning board approached the Landscape Architecture Department at SUNY-ESF requesting advice on how they should

approach their development constraints. The project was given to a design studio with the intent of exploring potential long-term development options in various locations throughout the town of Tupper Lake.

During design development, the following categories were to be addressed:

- Site reconnaissance and site analysis;
- Research on wood products-based economic development in the context of biophilic design in a biosphere reserve;
- Programming recommendations for the area and site development;
- A master plan including all of the studio's design recommendations;
- Site and area specific design recommendations including; sections, elevations, perspectives, etc. and recommendations for materials, green and gray infrastructure, etc., and;
- Recommendations for project phasing and funding.

Throughout the scope of the project, making connections between potential proposals and the availability of local and regional ecosystem-based resources is incredibly important. Of the several options for development strategies, a wood-based biorefinery was among the most feasible. With the projected design solutions, there is hope that the Town and Village of Tupper Lake will:

- See the community in a new way and has a better sense of the issues, opportunities, and constraints inherent in the physical structure of Tupper Lake;
- Develop a vision for the non-tourism economic future of the community;
- Identify projects that will assure a viable future for the community;
- Commit to a strong, on-going planning and development process to assure a viable future for the greater community.

Once a leading manufacturer and Tupper Lake's biggest employer, the Oval Wood Dish facility now sits vacant in the center of the village. The company was founded more than a hundred years ago and headquartered in Tupper Lake, manufactured millions of pieces of wooden cutlery, bowls, and more, and was one of the Adirondack region's most powerful economic engines. For fifty years, Oval Wood Dish dominated the flats along the North end of Raquette Lake with a sprawling complex of mills, machines, railroad tracks, generators, offices, warehouses, and employee housing. After sitting empty for many years, the building has recently been purchased but it remains unclear how the developers plans will meet the needs of Tupper Lake. The residents of Tupper Lake need a feasible re-use solution and a strategy that will allow residents to make a living in the town.

With a vast amount of timber resources and a deep history in the timber industry, the reuse of the vacant buildings as a wood-based biorefinery would not only increase economic development within the town but provide jobs and increase the tax base for the community. The proposed solution is broken down into three phases; Phyto-remediation, Revitalization, and Agriculture.

Figure 3 is the first phase, Phyto-remediation. Phase one focuses on re-developing the existing Oval Wood Dish buildings and repurposing them into spaces that generate revenue, provides jobs, and encourages the community to use.

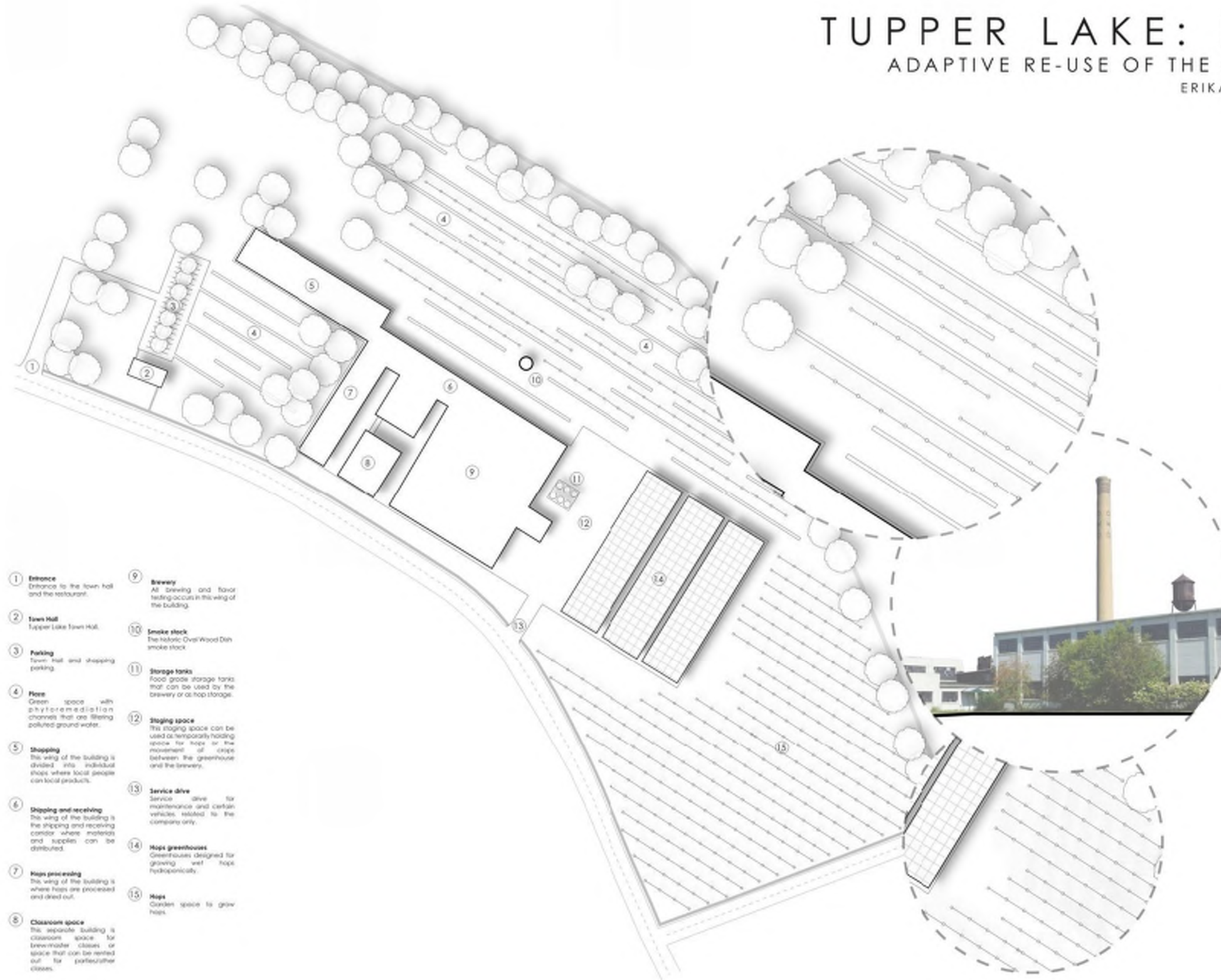
Figure 4 is the second phase, Revitalization. Phase two focuses on the development of a wood-based biorefinery on the Oval Wood Dish site, specifically the layout and clustering of buildings to make use of the best space and flow through the biorefining process.

Figure 5 is the third phase, Agriculture. In this phase, the project focusing on the site as a whole by using agriculture as the connecting factor. The site is a working landscape where hops or other crops can be grown and processed in the makers spaces in the newly renovated building.

TUPPER LAKE: PHASE ONE

ADAPTIVE RE-USE OF THE OVAL WOOD DISH SITE

ERIKA BOWEN | LSA 700 | FALL 2015



PHYTOREMEDIATION

Assuming that the Oval Wood Dish property is heavily polluted from past manufacturing processes, a natural remediation process is necessary in the aiding of cleaning hazards out of the soil and water table. Several channels will be constructed as mocked wetlands and will serve as a series of sand filtration systems where water will get filtered through each channel, getting cleaner as it passes through each one. The channels will also serve as outdoor hydroponic systems where edible plants can be grown and fish can be raised and eaten as well in the restaurant on site or local restaurants. After phase two is implemented, there will be opportunities of co-generation and access hot water from the extraction process can be used to heat the channels during the colder months.

REVITALIZATION

The repurposing of the Oval Wood Dish building is one of the key aspects in this project. The building is rich with history and an iconic symbol to locals and visitors. The adaptive re-use is utterly important in providing jobs and bringing in tourists. The building will be re-purposed as a multi-use building that will include a brewery, restaurant, niche shops, and classroom space. The multi-use complex will be a spin off of the current plans of the resort that is being planned for Big Tupper and will give visitors another place to visit. Some ingredients needed for the brewery and restaurant will be grown on site, the niche shops will provide business opportunities and give locals a place to sell their handmade products, and the classroom space can be rented out for brew-masters classes or party space.

AGRICULTURE

Growing hops is becoming the trend in agricultural products. Depending on location, climate, and hops variety, you can acquire different tastes that can start to be recognized as regional flavors. Hops will be grown hydroponically in greenhouses and in constructed channels outside to develop different types of flavors. Hydroponic hops is a new idea and can serve as an experimental site within the greenhouses. The hops grown outside will need to be planted in constructed underground planters with clean soil that is brought in to ensure that the hops are safe to produce an edible product and not harmed by the heavy pollutants in the soil. Other ingredients that are added flavors can also be grown on site and change with the beer flavors that are being brewed.

FIGURE 3: OVAL WOOD DISH PHASE ONE, TUPPER LAKE, NEW YORK

BIOREFINERY INTERVENTION

The Biorefinery concept is a great way to bring in new economics to a region. The process functions off of a natural resource that the Adirondacks has a vast amount of. The facility will extract natural elements from wood chips through a hot water extraction process that will allow the further manipulation of those materials into new products. Products that can be produced include but are not limited to: wood pellets, biodegradable plastics, industrial chemicals, and food grade flavor additives. The Biorefinery will provide more job opportunities, bring people into the region, and give research opportunities.

-
- 12** **Shipping and receiving**
All deliveries (except for wood chips) will be delivered to this building and dispersed internally.
- 13** **Loading docks**
Four loading docks and a large staging space for the movement of semi trucks.
- 14** **Trucks only**
Trucks only road for the fast and efficient delivery of wood chips.
- 15** **Entrance**
All vehicles can enter here and go to their designated parking or unloading spots.
- SECTION PERSPECTIVE

FIGURE 4: OVAL WOOD DISH PHASE TWO, TUPPER LAKE, NEW YORK

TUPPER LAKE: PHASE THREE

ECO-INDUSTRIAL PARK

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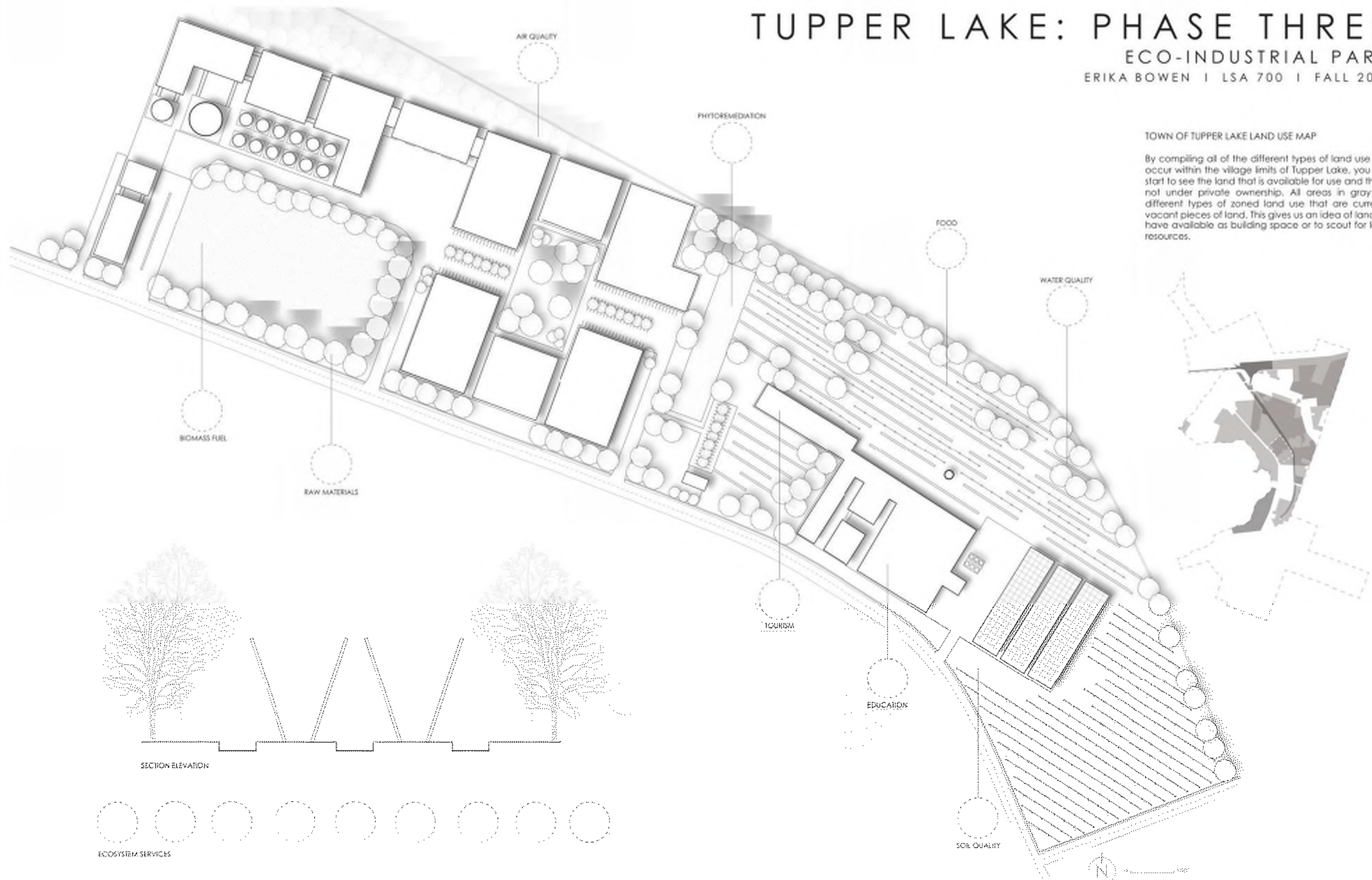


FIGURE 5: OVAL WOOD DISH PHASE TWO, TUPPER LAKE, NEW YORK

Even though the concept of an eco-industrial park is an unexplored type of industrial development, there are some built examples in the United States that are successful. Boeing Long Acres Industrial Park and the Ford Rouge Center are two industrial parks that have been designed and built to protect and enhance the natural environment.

BOEING LONG ACRES INDUSTRIAL PARK, RENTON, WASHINGTON



FIGURE 6: BOEING LONG ACRES INDUSTRIAL PARK, RENTON, WASHINGTON

Boeing Long Acres Industrial Park, designed by PWP Landscape Architecture, is a 212-acre former racetrack that was transformed into a wetlands/office park. The design of this site was strategic and well thought out

because architects, planners, and a wetland ecologist had to minimize the impact of development AND restore function to ecological systems. The encasing environment was ecologically sensitive and the methods of restoration through the planning and construction process protected and preserved beautiful wetlands that were incorporated into the design of the park. Not only does the site provide an aesthetic purpose, it provides a fully functioning landscape that connects existing water bodies, restores natural flow patterns, retains stormwater, filters runoff, and provides habitat. The surrounding forest provides a transition into the habitat that surrounds the site and references a historic agricultural past. This site is home to two ecologically sensitive areas that are both a framed view and protected by permeable paths that allow pedestrians to view these areas from a protective distance.

FORD ROUGE CENTER MASTER PLAN, DEARBORN, MICHIGAN



FIGURE 7: FORD ROUGE CENTER MASTER PLAN, DEARBORN, MICHIGAN

The planning and the design of the Ford Rouge Center transformed the manufacturing site into a sustainable industrial complex. As Ford Motor Co. made plans to expand their manufacturing facilities, they were faced with 50 million dollars of toxic stormwater cleanup that stemmed from impervious surfaces into the Rouge River. William McDonough and Partners, a multi-disciplinary design firm, developed a master plan that encompassed a new form of stormwater management within the landscape to go along with renovations and expansions. At the center of a system of wet meadow gardens, porous paving, hedgerows and bioswales lies a roof garden atop of a 1.1 million square foot truck manufacturing facility that attenuates, cleanses and conveys stormwater across the site. Landscape elements not only block the cold winter winds but frame the views of the industrial infrastructure and juxtapose the natural and the industrial making these structures more keenly felt by the public. Since the infrastructure was landscape based, construction costs were 1/3 of typical projects of this nature because of the minimal use of pipes. This project is recognized as one of the most iconic green roofs in the United States and has helped shape the green roof industry.

After reviewing the Oval Wood Dish, Boeing Long Acres Industrial Park, and the Ford Rouge Center Master Plan case studies, I began to see patterns of biophilic design strategies, and design opportunities including ecosystem services and forest bathing. To enhance user experience and work-related productivity, and increase the viability of ecosystems present on site, the topics of biophilic design, ecosystem services, and forest bathing should be further discussed.

DESIGNING FOR HUMANS

Humans are attracted to nature or spaces that make them feel a connection with nature. Integrating nature into design decisions will not only increase people's overall well-being and productivity in the workplace.

BIOPHILIC DESIGN

Biophilia is the inherent human tendency to seek connections with nature. When incorporated into the built world, biophilic design uses natural materials, natural light, vegetation, and other experiences of the natural world. Good biophilic design is thinking of people as an organism and respecting the mind-body systems as indicators of health and wellness. It draws from health conditions, socio-cultural norms and expectations, past experiences, and frequency and duration of the user experience to create spaces that are inspirational, restorative, and healthy. "Biophilic design must nurture a love of place."

As outlined in the *14 Patterns of Biophilic Design* by Terrapin Bright Green, biophilic design can be classified into three categories: (1) Nature in Space; (2) Nature in Analogs and; (3) Nature of the Space – all providing a structure for understanding and enabling the incorporation of a rich diversity of strategies into the built environment.

Nature in Space focuses on the direct, physical, and ephemeral presence of nature in space including plant life, water, and animals, as well as breezes, sounds, and scents to name a few. The strongest experiences are achieved through the creation of meaningful, direct connections with these natural elements through diversity and multi-sensory interactions. There are seven biophilic design patterns that encompass Nature of Space:

- “1. Visual Connection with Nature. A view to elements of nature, living systems and natural processes.
2. Non-visual Connection with Nature. Auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems, or natural processes.
3. Non-rhythmic Sensory Stimuli. Stochastic and ephemeral connections with nature that may be analyzed statistically but may not be predicted precisely.
4. Thermal & Airflow Variability. Subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic the natural environment.
5. Presence of Water. A condition that enhances the experience of place through seeing, hearing or touching water.
6. Dynamic & Diffuse Light. Leverages varying intensities of light and shadow that change over time to create conditions that occur in nature.
7. Connection with Natural Systems. Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem.”

Natural Analogues address organic, non-living and indirect evocations of nature. Objects, materials, colors, shapes, sequences, and patterns found in nature are inspiration for artwork, ornamentation, furniture, décor, and textiles in the built environment. Mimicry of objects found in nature such as; shells, leaves, and organic shapes are an indirect connection with nature. Although these items are real, they are only analogous of the items in their natural state. There are three patterns of biophilic design encompassed in Natural Analogues:

“8. Biomorphic Forms & Patterns. Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature.

9. Material Connection with Nature. Materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place.

10. Complexity and Order. Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature.”

Nature of the Space addresses spatial configurations in nature that includes our innate and learned desire to be able to see past immediate surroundings, fascination with the dangerous and unknown, obscured views and revelatory moments, and sometimes even phobia-inducing properties when they include a trusted sense of security. The strongest experiences are achieved through the deliberate creations of engaging spatial creations intermingled with patterns of Nature in Space and Natural Analogues. Nature of Space encompasses four patterns of biophilic design:

“11. Prospect. An unimpeded view over a distance, for surveillance and planning.

12. Refuge. A place for withdrawal from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.

13. Mystery. The promise of more information achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment.

14. Risk/Peril. An identifiable threat coupled with a reliable safeguard.”

Biophilic design patterns are flexible and replicable strategies for enhancing the user experience that can be implemented under a range of circumstances. Biophilic design interventions are based on the needs of a specific demographic in a particular space and are likely to be developed from a series of evidence-based

natural patterns. Since no two places are alike, the 14 patterns need to be transferable through a range of scales and density types (rural, suburban, and urban) so that they can be applied to any type of situation. Each of the 14 patterns supports the reduction of stress, cognitive performance, emotion and mood enhancement, and the human body.

ECOSYSTEM SERVICES

Ecosystem services are benefits that humans gain freely from properly functioning ecosystems. These benefits are often times integral to the provisioning of clean drinking water, the decomposition of wastes, and the natural pollination of crops and other plants. The *Millennium Ecosystem Assessment* categorizes ecosystem services into four broad categories; supporting, provisioning, regulating, and cultural services.

Supporting services are regarded as the basis for services in the other three categories (provisioning, regulating, and cultural). These include services such as nutrient recycling, primary production, soil formation, habitat provision and pollination that make it possible for the ecosystems to continue providing a food supply, the regulation of floods, and water purification.

Provisioning services are the ecosystem services that describe the material and energy outputs from ecosystems. These outputs include food (crops, seafood, wild game, and spices), raw materials (lumber, fuel wood, organic matter, fodder, and fertilizer) water, minerals, and energy (biomass, hydropower, solar and wind power).

Regulating services are the benefits obtained from the regulation of ecosystem processes. Some of those benefits include carbon sequestration, climate regulation, regulating species populations, waste decomposition and detoxification, purification of water and air, and pest and disease control.

Cultural services are the non-material benefits people obtain from ecosystems. They include recreational experiences, science and education, therapeutic services, and using nature for spiritual or historical values.

The concept and design of the Enterprise Park at Calverton as an eco-industrial park stems, in part, from the four categories of ecosystem services. Each service is represented throughout the site and will aid in the overall ecosystem health.

Supporting services are displayed through the enhancement of the pine barrens habitat and sensitive ecosystems that are currently present on site. By regulating the pine barrens habitat and native grasslands, there will be a stable and supportive ecosystem that encourages wildlife, soil stabilization, groundwater purification, and pollination.

Provisioning services provide material and energy outputs that will allow businesses to utilize green energy; wood-based fuel, biomass, hydropower, solar, and wind power, where applicable, to specific industrial processes. To help source resources for the wood-based bio-refinery, willow biomass will be grown and harvested on site and businesses will be encouraged and given incentives to make use of other types of green energy to run their industrial processes.

Regulating services such as minimizing on site vehicular traffic, regulating/enhancing species populations present on site, waste decomposition, and purification of water and air will increase the benefits of ecosystem processes. By designating a daily commuter parking area to the exterior of the site and not allowing through traffic into the interior of the site and by designating a facility for a shipping and receiving center, the vehicular carbon footprint will be decreased immensely.

FOREST BATHING

In the past several decades, there have been scientific studies that research the ways that forest immersion affects a person's well-being. "Shinrin-yoku" or forest bathing is a Japanese phrase that means bathing in a forest atmosphere and taking in the forest through the five senses. This is not exercise, hiking, or jogging.

It is simply being in nature and making a connection through your sense of sight, hearing, taste, smell, and touch to achieve positive health benefits and peace of mind.



FIGURE 8: FOREST BATHING

Designing an eco-industrial park that engages the five senses and allows people to make a connection to nature will:

- Reduce blood pressure
- Reduce stress
- Improve cardiovascular and metabolic health
- Lower blood sugar levels
- Improve concentration and memory
- Decrease depression
- Improve pain thresholds

- Improve energy levels and vigor
- Boost immune system
- Accelerated recovery from illness
- Increase anti-cancer protein production
- Aid in weight loss
- Reduce anxiety
- Improve mood
- Increase sleep
- Increase ability to focus

To design an environment that engages the five senses, the planning and development team must use variations of sounds, smells, visual compositions, textures, colors, seasonality, furnishings, art, shadows, lights, temperature, closure, openness, water, and plant types to create spaces where one can forest bathe. By using different sensory elements, spaces like outdoor classrooms/meeting space or contemplation areas can be created to maximize the forest bathing experience.

A successful eco-industrial park will embrace the idea of forest bathing during design and development phases to create an atmosphere where employees can feel at ease and relaxed in the workplace. Providing an environment in the workplace where employees can immerse themselves in nature will not only increase the health and well-being of employees but increase worker productivity.

NEED FOR PARAMETERS

The concept and definition of eco-industrial parks were developed in the early 1990's, but what has not been developed yet is a standard set of design parameters outlining strategies and methods on how to reach the goals of an eco-industrial park and how to approach design constraints based on the type of site. With increasing technology and worldwide trend in green development, traditional industrial parks will be

a thing of the past. The re-development and new development of these industrial sites need guidelines and strategies for them to best achieve site-wide sustainability, lessen environmental impacts, and enhance ecosystems.

ECO-INDUSTRIAL PARK DESIGN PARAMETERS

The Hinton Government Center Located in Alberta, Canada, created a set of design guidelines to develop the Hinton Eco-Industrial Park. Referencing these design guidelines, I was able to create a set of design parameters so that developers, planners, engineers, and architects involved in the design process of an eco-industrial park fueled by a wood based biorefinery can achieve a holistic, ecologically sensitive, development solution. This set of parameters will provide guidance, strategies, and transferability in developing design elements to achieve the design goals. The development guidelines are not intended to be prescriptive, but to encourage innovations and transferability.

The developed design parameters have been created to achieve an industrial park that:

- Uses ecosystem services including supporting services, provisioning services, regulating services, and cultural services
- Addresses carbon sequestration and climate regulation both indoors and outdoors that are directly affected by the amount, placement, and types of plant materials used in a planting scheme
- Allows stormwater to be captured, cleaned, and released
- Uses sustainable energy and fuel sources
- Minimizes carbon footprint of transportation within the site
- Uses co-generation between businesses and neighboring communities by using excess energy
- Increases tax revenues and new jobs in the community
- Provides functional and attractive outdoor contemplation space that supports the concepts of forest bathing and therapeutic landscapes leading to increased productivity
- Maximizes environmental and business performance for the whole eco-industrial park
- Includes a variety of safe and functional pedestrian linkages throughout
- Maximizes efficiency of resource use through integrated design

- Minimizes energy usage through efficiency, sharing, and waste recovery
- Reduces impacts on the environment through the management of the construction phase, daily use, and maintenance practices

In achieving these goals, development is anticipated to be more ecologically sensitive and more inclusive to employees that work on site than in a conventional industrial park.

RECOMMENDED DESIGN PARAMETERS

These guidelines reflect the flow of site and building design in an eco-industrial park that is anchored by a wood-based biorefinery within the New Forest Economy Initiative. The planning team can reference these guidelines as they progress through the design process from broad eco-industrial networking strategies to character and material details. Within this overall progression, these guidelines interrelate frequently and are general enough to be applied to multiple projects in different situations. The transferability of these guidelines allows them to be applied to different situations and locations. It is essential to consider all guidelines together and look for synergies between systems because integration can occur when considering networking opportunities, siting and orientation, and details that are worked out later in the design process. Below are the parameters, behind each one are initials indicating whether that parameter came from the HEIP (Hinton Eco-Industrial Park), HEIP-EB (Hinton Eco-Industrial Park modified by the author), or EB (created by the author).

PERFORMANCE REQUIREMENTS

It is the author's humble opinion that at a minimum, designs must meet guidelines as follows:

- a. All 59 required guidelines marked **R**
- b. As many of the 15 optional guidelines as possible marked **O**

Many of these requirements can be met during the design stage. Parameters that have not been incorporated need an explanation as to why that specific parameter was not included in the design/construction.

DEVELOPMENT GUIDELINES

Pre-Development Planning

At the core of “an eco-industrial park’s competitive advantage, is developing and maintaining efficiencies by sharing resources and waste reuse among its businesses. Identifying and evaluating opportunities for enhanced performance through joint efficiency initiatives is essential to successful eco-industrial networking” (HEIP).

Preparing a Development Program

R. Identify resource needs and waste production of the proposed operations and/or businesses anticipated on the site. Include energy, water, materials, human resources, training, logistics, transportation, etc. Include approximate quantities where known (HEIP).

R. Obtain existing business resource needs and waste production of existing or future businesses on site and assess opportunities to reduce resource needs and waste generation through sharing and any other strategies (HEIP).

- o For example: recover waste heat and/or water from wastewater industrial processes for reuse or sale to nearby businesses (HEIP-EB)

Integrated Design Principles and Process

R. Use an Integrated Design Process (IDP) for site and facility design to identify and take advantage of synergies of various building systems and industrial processes (HEIP).

What is an Integrated Design Process (IDP)?

“An IDP involves collaboration between a wide range of people to design a building/facility. Usually, participants include not only architects and engineers, but also owners, potential tenants, contractors, specifiers and estimators. The team engages in interactive workshops from pre-design right through design development to construction.

Throughout, the team considers the design from a whole systems perspective, identifying synergies and working out conflicts between building systems. This approach consistently achieves higher performance buildings, often with little or no cost premium. While it can be more expensive than a conventional design process, it offers excellent return on investment.”

Innovista Eco-Industrial Park Development Guidelines, Hinton, Alberta, December 2011

PARCEL LAYOUT AND ORGANIZATION

The layout of the site, including the location and orientation of buildings, shipping and receiving areas, storage and holding areas, and temporary semi-truck parking has the biggest impact on the site’s appearance, economic, and environmental performance. It is intended that there are convenient accesses and linkages with adjoining businesses and strong visual connectivity with the public and vegetated areas that surround parcels (HEIP-EB).

Siting and Massing

R. Orient the building to provide strong visual, pedestrian, and semi-truck access connections with the natural, vegetated areas of the site (HEIP).

R. Orient and mass buildings to maximize opportunities for solar heating and cooling, natural lighting and ventilation (HEIP).

R. Locate parking along the outskirts of the eco-industrial park enclosed with natural vegetation, raingardens/bioswales to collect stormwater, pedestrian connectivity to electric shuttles and to; minimize carbon footprint, traffic congestion, and excessive parking on individual properties (EB).

R. Facilitate shared service areas such as garbage collection, shipping and receiving, day care for children and elderly, dining establishments, and stores where necessities can be purchased (EB).

O. Minimize the overall development footprint including building, warehousing, access roads and parking by considering stackable or alternative warehousing techniques, use of joint facilities, and building clustering (HEIP).

Building Orientation and Layout

R. Provide a convenient exterior entrance close to or facing access to the site from the pedestrian circulation system (HEIP-EB).

R. Provide safe, comfortable social and contemplation spaces for people in the interface between buildings and in the forest (these may be provided on a landscaped green roof area which may also provide a good view and assist with meeting stormwater objectives) (HEIP-EB).

R. Incorporate both internal and external recycling stations to make recycling convenient (HEIP).

R. Where possible, orient buildings and windows to maintain interior views of the surrounding scenery and landscaped/natural vegetation areas (HEIP-EB).

R. Site buildings at least 30' back from all roadways, leaving a vegetative strip in between the road and the building (EB).

R. Focus all development close to roadways for quick, seamless delivery and pick up of products if needed and to eliminate any traffic congestion (EB).

O. Where possible, locate office and staff social spaces at the side or rear of the building to provide views at the natural amenities such as landscaped and forested areas (HEIP).

ACCESS AND MOVEMENT

Safe and efficient movement of people, vehicles, materials, and supplies within and to and from sites is essential to the success of the eco-industrial park. At the same time, transportation and related infrastructure can be costly to build and maintain and can have significant environmental impacts. These design parameters are aimed at encouraging multi-modal transportation options for goods and people and identifying strategies to minimize costs and impacts of transportation infrastructure (HEIP-EB).

General Access

R. Design parcels to accommodate large shipping and maintenance vehicles and to minimize environmental impact (HEIP-EB).

R. Incorporate a freight rail connection to allow the movement of materials - eliminates the need for permits to move materials by semi-truck and eliminates the amount of semi-truck traffic onsite and in the community (EB).

Pedestrian Movement

R. Design pedestrian access routes for comfort and safety providing pedestrians and cyclists with safe pathways separated from heavy traffic where possible (HEIP).

R. Maintain attractive connections between primary buildings on each parcel to encourage walking and cycling (HEIP).

O. Provide bicycle end-of-trip facilities such as showers, lockers, and secure storage for staff (HEIP).

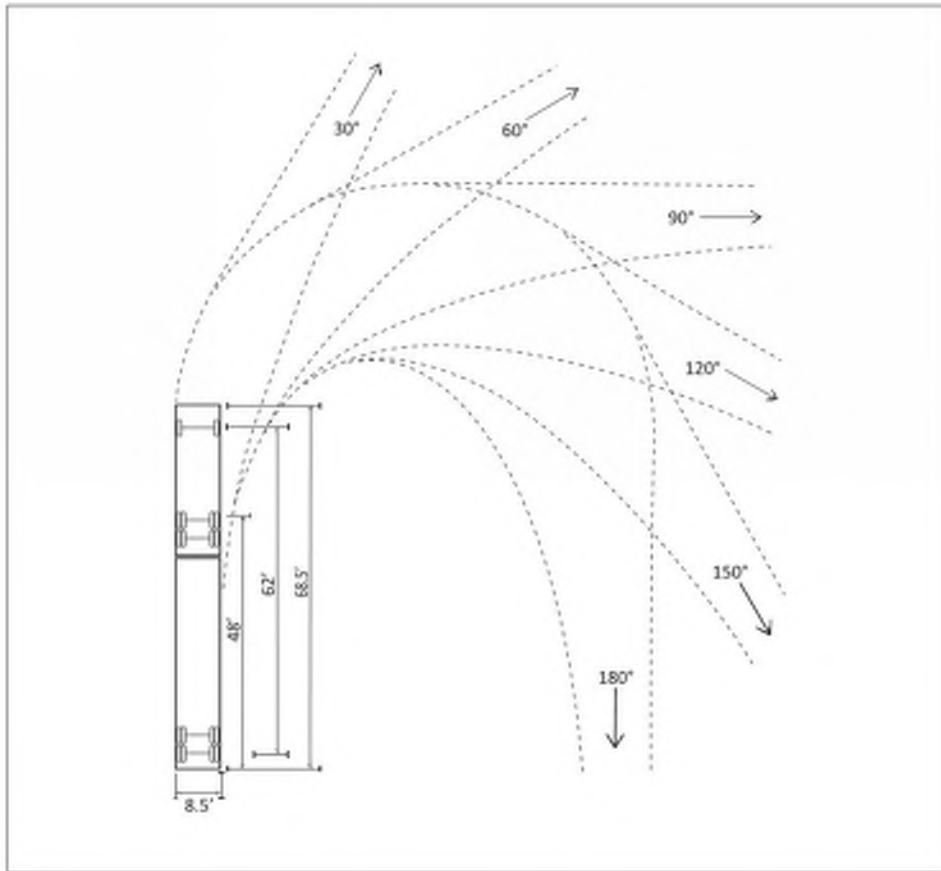


FIGURE 9: SEMI-TRUCK TURNING RADIUS

- R. Design road systems with wide roadways to accommodate heavy-impact transportation methods and to provide adequate turning radiuses (*Figure 9*) making pick-ups and deliveries quick and seamless (EB).
- R. Use a paving material that can withstand heavy impacts and frequent traffic for roadways (EB).
- R. Stop signs and stop lines are to be placed 30' back from intersections on all roads to allow semi-trucks and buses to make right turns without interfering with stopped traffic (EB).
- O. Where possible, use permeable paving materials in parking lots for lighter weight vehicles (EB).

O. Where appropriate, consider travel lanes or paths for small, low-impact transportation elements such as small electric delivery vehicles or small landscape maintenance vehicles (HEIP).

O. Facilitate ease of access from any parcel to a shared shipping and receiving center in a manner that minimizes conflict between modal types (HEIP).

Parking and On-Site Movement

R. Concentrate parking for daily commuters to one location and utilize an electric shuttle system with bus stops located frequently throughout the eco-industrial park, providing battery plug in kiosks for electric and/or hybrid vehicles (priority parking to vehicles that are electric or hybrid) (EB).

R. Plant trees and shrubs in retention basins and bioswales throughout the parking area to intercept precipitation, treat stormwater runoff, reduce surface heating, enhance appearance, and protect pedestrians from the elements (HEIP-EB).

O. Share parking and driveways between businesses with adjacent parcels to minimize paved surfaces as much as possible without affecting the transportation of goods (HEIP-EB).

O. Design parking spaces so that a portion of the vehicle hangs over into a landscape strip where possible (HEIP).

LANDSCAPING AND OPEN SPACE DESIGN

The eco-industrial park's natural environment and landscape is one of its defining and most functioning attractions. Landscape design is an opportunity to create a pleasing business environment, maintain the natural character of the site, and protect its ecological integrity. Landscape design can also contribute to the efficiency of energy and water systems and provide habitat for wildlife (HEIP).

Landscape Design

- R. Optimize the development area to protect existing vegetation, especially mature trees (HEIP-EB).
- R. Follow state and federal regulations of protection and conservation of sensitive ecosystems (EB).
- R. At least 60% of the site should be landscaped or green space using retention of natural vegetation and/or replanted with native species (EB).
- R. Use landscaped roofs and walls that incorporate appropriate native vegetation that can be considered in the 60% landscaped or green space parameter (HEIP-EB).
- R. Plant native trees to the North and West of buildings to protect them from winter winds and summer afternoon sun thus conserving the internal energy of the buildings and minimizing heating and cooling costs (HEIP-EB).
- R. Provide landscaping adjacent to pedestrian trails, playgrounds, picnicking areas, contemplation spaces, and outdoor meeting spaces integrating them with natural vegetation where possible (HEIP).
- O. Mulch planting beds to a minimum depth of 2-3" to reduce evaporative losses (HEIP-EB).

Plant Selection

- R. Include a variety of native groundcovers, shrubs, and tree species to provide habitat for native flora/fauna, aesthetics, and stormwater management (HEIP).
- R. Reduce the need for maintenance, pesticide use, and irrigation by selecting hardy, drought-tolerant, perennial species (HEIP).
- R. Provide habitat to support other local native species, particularly sensitive/threatened/endangered species (HEIP).

ENERGY SYSTEMS

Energy is a significant and rising cost of doing business. Energy use is also related to greenhouse gas emissions and reduced air quality. In industrial settings, there are significant opportunities to reduce energy use both within individual sites and through sharing of resources between different operations (HEIP).

Site-Level and Shared Energy Systems

R. Implement opportunities to produce on-site energy from renewable sources such as solar, geo-exchange, wind, biomass and co-generation (HEIP).

R. Utilize opportunities to share energy, heating and cooling among site areas and with other parcels (HEIP).

O. Consider opportunities to pool backup generation systems with other buildings and parcels (HEIP).

Building Process, Heating and Cooling Systems

R. Improve energy efficiency (EB).

R. Specify HVAC equipment that is designated as non-hydrochlorofluorocarbon (HCFC) or low-HCFC (HEIP).

Building Lighting Systems

R. Utilize natural lighting strategies in building design of window placements and building orientation (HEIP-EB).

R. Minimize lighting energy demand by using high-efficiency luminaries and bulbs (HEIP-EB).

O. Use seasonal and/or user-controlled shading techniques to take advantage of sunlight while minimizing unwanted heat gain in the summer (HEIP).

WATER, STORMWATER, AND WASTEWATER SYSTEMS

The intent of these parameters is to minimize consumption of potable water, to facilitate the reclamation and re-use of stormwater, and to ensure wastewater treatment is managed properly.

Integrated Water Infrastructure Systems

R. Consider systems to use non-potable water sources where appropriate in industrial processes, wetland flow stabilization and, irrigation (HEIP-EB).

- For example: consider the feasibility of roof runoff storage and distribution to provide temporary non-potable water supplies, consider designing water systems to use high quality clean and potable water only for drinking water and processes that require clean water (HEIP-EB)

O. Consider double plumbing buildings to provide a cost-effective opportunity to retrofit later with non-potable water systems. For example: bringing cooling water from another operation to your building for use in process operations (HEIP).

Stormwater

R. 60% of the lot must be permeable and can be achieved by using the following types of strategies (HEIP-EB):

- landscaped areas
- green roofs
- porous driving surfaces

R. Plan surface runoff management strategies into the landscape design using strategies such as (EB):

- Direct roof runoff into infiltration basins

- Capture roof runoff for irrigation
- Develop green roofs
- Use dry-wells and/or percolation swales
- Use native plants that have adapted to the amount of water available on site

R. Design parking lots and other paved areas to minimize negative impacts on surface runoff volume and quantity using strategies such as (EB):

- Reduce roadway surfaces without jeopardizing the ability for large semi-truck traffic to navigate throughout the site
- Direct runoff to landscaped filter strips, bio-swales, and bio-filtration strips
- Install permeable/semi-permeable roadway surfaces in any new development and incentivize older developments to upgrade

O. Construct a water feature, wetland area, etc. that doubles as a storm pond for on-site stormwater retention (HEIP).

Wastewater System

R. Design plans for a wastewater clarifying tank is required for each lot and to be located with easy access for a vacuum service truck (HEIP).

Water Efficiency

R. Consider opportunities to re-circulate water including collected stormwater or high-quality wastewater within industrial operations and between businesses (HEIP).

R. Use high-efficiency fixtures and fittings within buildings such as: showerheads and waterless urinals to conserve water (HEIP-EB).

R. Consider alternative irrigation options for landscaping such as no system, the use of a temporary high efficiency drip irrigation system, or the use of collected stormwater or treated wastewater (HEIP-EB).

R. Use processing/manufacturing equipment that is water efficient (HEIP).

DESIGN CHARACTER AND MATERIALS

The character of an eco-industrial park should communicate its special nature to users and visitors, and it should also create a high-quality environment that sets it apart from other industrial parks. These parameters are intended to create a high performing, state-of-the-art, leading edge biorefinery powered eco-industrial park that also enhances the aesthetics of the natural surroundings. The guidelines for material selection and use are to support these goals and help to minimize the environmental impacts associated with different types of materials (HEIP).

Design Theme

The character and development should reflect the community image and portray the concept of the New Forest Economy Initiative (EB).

R. Façade Components: consider using materials that mask the typical image of an industrial building (EB).

R. Design buildings roofs with eco-friendly materials that allow the planting of green roofs (EB).

R. Distinctively indicate building entries so that visitors can easily distinguish them upon arrival (EB).

R. Apart from windows and doors, on exterior walls use green walls and encourage the growth of vines for aesthetics and building heating/cooling control (EB).

R. Use a common language style to indicate directions and label businesses/buildings (EB).

R. Extend the front façade theme to side walls that are visible from the street (HEIP).

Detailing

R. Create visual interest by adding details to the front façade of the building. As an alternative to detailing the entire front façade, less architecturally significant portions of the front facades of buildings may be set back and screened from public view by mature, dense landscaping (EB).

R. On other building faces, provide elements that create visual interest on building walls adjacent pedestrian routes and/or densely landscape these areas (EB).

R. To increase public and visitor's awareness and interests, implement opportunities to display objects and symbols of ongoing industrial activities, innovative practices, and outdoor art (EB).

O. In multi-building complexes, maintain a consistent architectural concept using complementary design, material, and colors (EB).

Structural Design and Material Selection

R. Design buildings to be deconstructed and/or recycled easily (HEIP).

R. Choose materials that (HEIP):

- Can be easily recycled at the end of their life span
- Maintain a high level of indoor air quality in all rooms/covered areas including low emissions finishes, are rapidly renewable, are produced from local manufacturers and/or producers as much as possible
- Have been re-used, and are made from high recycled content
- Can withstand local weather conditions

R. Use natural elements and features showcasing local species indigenous to the region (HEIP).

O. Minimize the use of pressure-treated lumber and other products that may release contaminants into the soil (HEIP).

CONSTRUCTION

Through careful planning and management, the negative impacts of construction can be minimized (HEIP).

Construction Management

R. Develop and implement a construction management plan that addresses (HEIP-EB):

- Waste minimization, separate waste materials for recycling where possible
- Effectively manage hazardous materials and wastes
- Minimize health impacts of indoor air quality on construction personnel
- Minimize site areas to be disturbed there by retaining natural vegetation, protect areas of natural vegetation from damage by fencing them, and maintain creek water by minimizing pollution, erosion and sedimentation

These guidelines are written so that an eco-industrial park will create a sense of place that is not just a collection of buildings but a multi-faceted system with maximized environmental and business performance. The eco-industrial park will be functional, aesthetically pleasing and will maximize efficiency and minimize energy uses.

CHALLENGES OF USING PARAMETERS IN DESIGN

Design is the process of creating solutions to solve a problem. To reach these solutions, the design process tests the limits of the factors that ultimately lead to a solution or solutions. In this case, these design parameters will be broken down, dissected, and have their limits tested while the planning team works through the design constraints of the site, the result being that not all parameters are equally applied in

each project. With the above in mind, lets take a look at the potential for redesign at the Enterprise Park at Calverton site.

THE ENTERPRISE PARK AT CALVERTON SITE

A key aspect of the New Forest Economy Initiative is to identify communities that can support a bio-refinery powered eco-industrial park. There are several parameters that a community must meet that would make it an ideal location for New Forest Economy development;

- Defunct architecture from a previous industrial practice or existing industrial businesses
- Loss of economic vitality and jobs due to the closure of a major employer or lack of employment opportunities due to employee downsizing or younger generations leaving and not returning
- Abundance of woody natural resources within a 75-mile radius
- Location and the availability and type of travel infrastructure
- People to fill vacant jobs

The location of the Enterprise Park at Calverton and the existing establishment of an industrial park make for an ideal situation to develop a bio-refinery powered eco-industrial park. With the closure of the Naval Weapons Industrial Reserve Plant, the town of Riverhead lost 1.1 million dollars in taxes and thousands of people lost their jobs. Currently, vacant buildings have been rented out to various types of businesses providing jobs and contributing to a small portion of the tax base but not nearly meeting the potential that the site had and could have in the future.

Through residential and commercial landscaping maintenance practices, clearing, grubbing and scrubbing, and selective timber harvesting, there is an abundance of natural timber resources available on Long Island and the New York City Metropolitan area that could potentially fuel a wood-based biorefinery. By utilizing the railroad, these materials are easily transportable to the site without having to apply for permits for semi-truck access throughout New York City. There is also the potential to further research willow biomass and grow willow stands on site that could be harvested as woody biomass for the bio-refinery.

SITE ANALYSIS

Using an existing site survey and aerial imagery, a site analysis was completed to determine existing components that are on site. Information extracted from the site survey was categorized relevant to; existing infrastructure, and existing habitat types.

Figure 10 is an analysis of the existing infrastructure currently on site. Access to the site can be obtained off of Middle Country Road to the North and Grumman Boulevard to the South. There are two runways; the Western Runway is currently inactive, and the Eastern Runway is currently active and maintained. All of the developed area is in between the two runways with smaller access roads connecting various types of businesses. To the Southeast of the site along Connecticut Ave, there is an active rail spur that crosses Grumman Boulevard and extends into the center of current development on site.

Figure 11 is showing the types of habitats currently present on site.

- Pine/Spruce/Conifer Plantation – Tree plantations can be observed in several locations to the North and Eastern runway. Records outlined in the *Proposed Redevelopment of EPCAL Property* document indicate that these tree plantations were established during the 1960's and various types of conifers; pines, spruces, and larch were planted. Successional vegetation from surrounding wooded and grassland habitats is present to dominant species amongst the planted trees due to the lack of management.
- Successional Old Field – The majority of the area immediately adjacent to both the Eastern and Western runways currently supports grassland habitat. The grasslands can best be defined as a meadow that is dominated by forbs and grasses that have been cleared and then abandoned. The disturbance that has maintained this grassland community is the constant maintenance of the runway areas. The grassland cover is generally dense and is dominated by a number of different grass and forbs species such as; broom sedge, Indian grass, switchgrass, sweet everlasting, horse

weed, and sickle-leaf golden aster. These grasslands are a significant habitat for a diverse range of rare grassland bird species and is also the largest remaining grassland community (640) acres on Long Island.

- Pitch Pine-Oak Forest – The pitch pine-oak forest ecological community is a primarily forested habitat that occurs to the North of the Western runway as well as some areas to the North and South of the Eastern runway. Pitch pine-oak forests are mature, closed canopy forests with a relative abundance of pitch pine and oak species, an extensive layer of heath low shrubs, and a sparse herbaceous layer. The habitat typically occurs on well-drained, sandy soils of glacial outwash plains or moraines and thin, rock soils of ridgetops. The dominant tree species include pitch pine mixed with one or more of the following oaks; scarlet oak, white oak, red oak, or black oak. The relative abundance of pitch pine and oak varies greatly. The understory shrub layer is usually very developed with scattered patches of scrub oak and an abundance of blueberries and huckleberries. The herbaceous layer is sparse and can include bracken fern, Pennsylvania sedge, and wintergreen.
- Pitch-Pine-Oak-Heath Woodland – The pitch-pine-oak-heath woodland is a community type that occurs in well-drained, infertile, sandy soils. It occurs infrequently and in small scattered pockets at the Southeastern area of the site. The structure of this community is either an open canopy of pitch pine and white oak with a dense understory shrub layer, dominated by shrub oak and scattered heath species OR a closed, dense canopy of pitch pine and white oak with a relatively sparse shrub layer. The density of the shrub layer is inversely related to the density of the tree canopy cover. The herbaceous layer is typically sparse in both cases and can include bearberry, heathers, and Pennsylvania sedge. This habitat type has adapted to periodic fires with an occurrence of every 15+ years and requires a greater burn frequency than occurs within the pitch pine-oak forest community.

- Wetland and Aquatic Habitats – According to the *Proposed Redevelopment of EPCAL Property* document, on site wetland and aquatic habitats are classified using the National Wetlands Inventory Cowardian Classification system and there are nine New York State Department of Environmental Conservation regulated wetlands located entirely or partially within property boundaries. The property supports a pond quality in the Northeastern portion of the site that is identified as a tiger salamander breeding pond recognized by the New York State Department of Environmental Conservation.
- Paved Road/Path – The Western and Eastern runways and internal roadways are best described as surfaces paved with asphalt, concrete, brick, stone, etc. where there may be sparse weedy vegetation within the cracks of the paved surface.

Being a site with a sensitive ecosystem and having a protected species and habitat type present, this proposes special design challenges.

SPECIAL CHALLENGES

Given the range of types, sizes, and locations of eco-industrial parks, each one is different and poses its own special challenges. The Enterprise Park at Calverton site has two types of protected ecosystems; the pine barrens and the habitat of the eastern tiger salamander, present that will need specialized protection through development, construction, and in perpetuity of the site. These special challenges are easily catered to through flexible design principles and are what makes each site unique.

The Eastern Tiger Salamander

The eastern tiger salamander is one of the largest species of terrestrial salamanders in the United States. Adults can range between seven and eight inches long with sturdy limbs and a long tail. The body color can be dark brown to almost black and irregularly marked with olive to yellow colored blotches.

The eastern tiger salamander is part of the group referred to as mole salamanders meaning that it spends most of its life underground. On Long Island, they emerge from their underground burrows to migrate at night, usually in the rain, to breeding ponds. After a short interaction with a female consisting of the male pushing his nose against the female's body, eggs are laid in a mass and attached to twigs or weed stems underwater. The female can deposit one or more egg masses containing 25-50 eggs per mass. Larvae will hatch after about four weeks and remain in pods until late July or early August. The larvae then transform into air breathing sub-adults measuring between four and five inches and they will leave ponds at night during wet weather to begin their underground existence. It takes four to five years for the eastern tiger salamander to reach sexual maturity. They eat small vertebrates and invertebrates and can live 12-15 years.

The eastern tiger salamander can be found along the East Coast from Southern New York to Northern Florida, West from Ohio to Minnesota and Southward through Eastern Texas to the Gulf. The eastern tiger salamander inhabits sandy pine barren areas with temporary or permanent pools for breeding. In New York, the eastern tiger salamander is found only on Long Island with most of the known breeding colonies restricted to the central pine barrens. In the absence of natural pools and ponds, it may breed in man-made depressions filled with water.

The loss of habitat from heavy development is the key factor of extirpation of this species in Long Island. Recent surveys have identified 90 breeding ponds, 9 of which are located on Enterprise Park at Calverton property, in New York in Nassau and Suffolk counties. It's status at these remaining sites is tenuous because of pesticides and other contaminants, threat of further development, and other land use patterns. The disturbance of ponds, the introduction of predatory fish species into permanent pools, and the growth of bullfrog populations threaten the eastern tiger salamander's annual reproduction. Recreational activities associated with off-road utility vehicles and increased construction of roads impacts breeding sites and habitat. These wetlands have been classified as class I wetlands meaning:

A. "At least 50% of the wetland has been disturbed or affected by a human activity or development by (1) or more of the following

(i) Removal or replacement of natural vegetation

(ii) Modification of the natural hydrology.

B. The wetland supports only minimal wildlife or aquatic habitat or hydrologic function because the wetland does not provide critical habitat for threatened or endangered species listed in accordance with the Endangered Species Act of 1973 (16 U. S. C. 1531 et seq.) and the wetland is characterized by (1) of the following:

(i) The wetland is typified by low species diversity.

(ii) The wetland contains greater than fifty percent (50%) areal coverage of nonnative invasive species of vegetation.

(iii) The wetland does not support significant wildlife or aquatic habitat.

(iv) The wetland does not possess significant hydrologic function."

- Appendix I-6A Isolated Wetland Definitions Classes Exemptions, Waterways Permitting Manual, February 27, 2006

Using design strategies from the Boeing Long Acres Industrial Park as a reference, the existing eastern tiger salamander habitat will be known as a protected conservation area of the eco-industrial park.

Grasslands

The Long Island Pine Barrens are a rich matrix of softwood forests, ponds, bogs, swamps, and grasslands. Due to heavy development after World War II, habitats including the grasslands were heavily impacted, most of the remaining grasslands on Long Island are located within the pine barrens. As with all other

habitats present within the pine barrens, grasslands contribute significantly to the overall species diversity of the ecosystem, supporting a wide range of specialized plant and animal species that are dependent of this habitat. However, the grasslands are at risk both from human encroachment and from processes occurring within the pine barrens.

Grasslands are an earlier successional community meaning that if left undisturbed it will eventually be colonized by shrubs and trees, eventually leading further into succession and converting to a forest-type habitat. If grassland habitats are not carefully managed and maintained, their quick conversion into a forest-type habitat threatens many species of birds and their nesting/breeding habitat. Due to its vulnerability to natural succession, grasslands cannot be preserved without careful stewardship and ongoing management practices to preserve its viability as a grassland and prevent its development into shrubby, forested land.

Currently present on the site, several hundred acres of grasslands are present both on the Eastern and Western sides of the runways. By concentrating development to the central region of the site, the exterior grasslands can be preserved and/or enhanced to be functioning, healthy ecosystems.

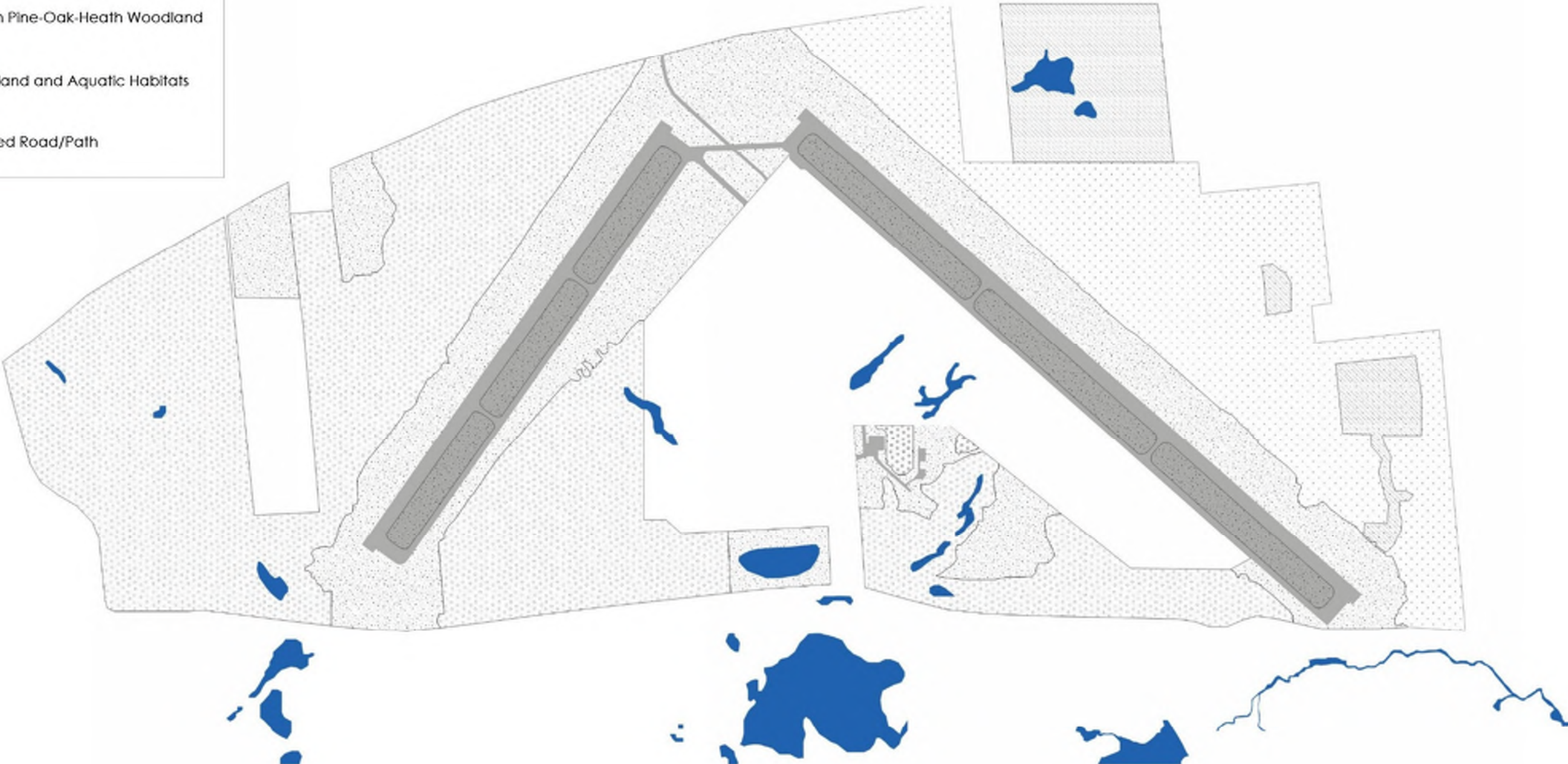


FIGURE 11: EXISTING INFRASTRUCTURE, ENTERPRISE PARK AT CALVERTON, RIVERHEAD, NEW YORK

THE DESIGN PROGRAM

By creating an industrial ecosystem, influences from ecology and human well-being begin to create a design narrative that connects the region, the town, and the site at a multitude of different levels. Once the connections are made, the flow of materials and processes becomes a fully functional natural system. Through human influence, the rural economy is the connection between entities of a larger system of industrial megaregions and will be able to help drive the United States economy by utilizing natural resources and relationships from other regions within New York state and the United States. There is an abundance of natural wood fibers and woody organic matter throughout Long Island from the reversion of farmland back to forests and landscape maintenance practices that cannot be mitigated without producing some sort of carbon footprint.

A PROTOTYPICAL DESIGN APPROACH TO THE ENTERPRISE PARK AT CALVERTON

With countless development ideas as to how to re-define the Enterprise Park at Calverton property, developing the site into a bio-refinery powered eco-industrial park is a step into the future and sets the standard for a whole new type of industrial development. This approach of developing a prototypical eco-industrial park; the first of its kind, will pave the way into future eco-industrial developments and will serve as precedence for decades to come.

Figure 12 is the re-development, using the eco-industrial park design parameters as guidelines, of the Enterprise Park at Calverton. There are components of all of three types of eco-industrial parks; co-location/proximity, shared by-products, and cleaner production, incorporated into the site design. The concept of the site stems from the New Forest Economy Initiative with a wood-based biorefinery representing the state-of-the-art technology that will be used to enhance an existing industrial site and revive the local community.

The anchor element of the site is a wood-based biorefinery and there is the ability for the further processing of by-products from the biorefinery to take place in other buildings on site. All buildings are clustered and located near resources and recycling facilities, companies are encouraged to use waste energy from other companies in their own industrial processes, and there is an emphasis on cleaner production and carbon sequestration throughout the entire site.



FIGURE 12: ENTERPRISE PARK AT CALVERTON MASTER PLAN, RIVERHEAD, NEW YORK

BIOREFINERY

The re-development of the Enterprise Park at Calverton site into an eco-industrial park will have a wood-based biorefinery as it's anchor element. The anchor element is the main corporation where all other corporations depend on its by-products for their own repurposing or they count on it as their main source of power. In this case,

the biorefinery will provide an industrial sized boiler system that will use the wood pellets that are created



FIGURE 13: BIOREFINERY ENLARGEMENT AND SECTION

The site plan and section above shows a layout example for a biorefinery that can process 700 tons of wood matter a day. Trucks loaded with woody matter will enter onto the site and into a truck dumper where the

wood chips will be dumped into an underground chamber, onto a conveyor belt, and into the biorefinery building where the extraction process takes place. After the woody matter has been through the extractor, the wood chips and liquid elements are moved into the adjacent building for further processing and research.

CIRCULATION AND PARKING

Commuter parking is concentrated to the Southern portion of the site. To meet the requirements of design parameters, parking must be located to the exterior of the site to help mitigate carbon footprint and traffic congestion on site like shown in *Figure 14*.



FIGURE 14: PARKING ENLARGEMENT

Daily parking is provided for commuters who drive automobiles to and from the campus. Priority parking will be given to methods of transportation that are environmentally friendly such as; hybrid or electric vehicles and cyclists. Several charging stations are provided for environmentally friendly vehicles. Once people have arrived at the eco-industrial park by their choice of transportation, they will then utilize the shuttle system to get where they need to be. There are several shuttle stations located near the commuter parking lots that commuters can use to get to their places of employment. The shuttles run a consistent schedule that is to be determined based on peak travel hours. Bicycles and other forms of non-motorized transportation are permitted on site, temporary storage facilities are available for short-term storage. The only vehicular thru traffic allowed onsite is for shipping/receiving and persons who need handicap accessible parking/access to buildings and amenities. Any other traffic must obtain a permit through campus security/law enforcement.

SHIPPING AND RECEIVING



FIGURE 15: SHIPPING AND RECEIVING ENLARGEMENT

The shipping and receiving center mitigates traffic and the carbon footprint from vehicles and expelled energy of several delivery trucks delivering to multiple businesses daily, sometimes several times a day. The proposed shipping and receiving center shown in *Figure 15* is located at the Southeast corner of the site.

This is an ideal location for access by all methods of transportation; airplane, semi-trucks, box trucks, etc. because of the close proximity that the shipping and receiving center is from a major roadway, a rail line, and the functioning runway. Delivery vehicles can access the site quickly, unload their delivery for processing, and exiting the site in a timely fashion. From the receiving center, smaller hybrid/electric vans and box trucks will be used to disperse products to their destinations.

BUILDINGS



FIGURE 16: INDUSTRIAL BUILDING



FIGURE 17: INDUSTRIAL BUILDING

The buildings in an eco-industrial park need to be aesthetically pleasing and designed architecturally to look like modernistic buildings. When designing these buildings, architects and engineers should consider keeping as much industrial type infrastructure under roof as possible. If this is not possible like shown in *Figure 16*, this will be a design challenge for them to make industrial infrastructure aesthetically pleasing and atypical of what traditional industrial infrastructure looks like. In *Figure 16*, heavy vegetation and plantings are used close to the building to help mask the traditional looks of industrial buildings. In *Figure 17*, a modernistic building façade is used to mask the look of a traditional industrial building.

PROTECTION OF EASTERN TIGER SALAMANDER HABITAT

The protection of the eastern tiger salamander habitat is critically important. Through construction and development, these areas need to be closed off with no access and as little disturbance as possible. The surrounding areas will be designed so that people are able to utilize the landscape for forest bathing and recreational purposes, but natural vegetated buffers will serve as barriers so that there is no access into these sensitive habitats as shown in *Figure 18*.



FIGURE 18: EASTERN TIGER SALAMANDER CONSERVATION AREA



FIGURE 19: ENLARGEMENT OF EASTERN TIGER SALAMANDER CONSERVATION AREA

Pictured above in *Figure 19*, you can see the areas surrounding the conservation areas are developed. Access to the conservation areas is prohibited unless it is for research, and the dense vegetation shown in *Figure 18* will be a natural protection barrier.

PROTECTION OF THE GRASSLANDS HABITAT

The protection of the grasslands is also critical to the site because of their importance to the greater ecosystem. The grasslands is the home of several types of nesting birds that need an undisturbed habitat for mating and raising their young, some types of birds need 25+ acres of undisturbed and unfragmented grassland to nest. The maintenance of the runways have kept the grasslands from going into a successional stage, this type of maintenance should be continued outside of mating and mothering season of bird species.

PINE BARRENS PLANT PALETTE

The Long Island Pine Barrens is a large, ecologically functional landscape that is in the midst of a heavily urbanized area. There have been challenges in protecting the hydrological and ecological integrity of the Long Island Pine Barrens while accommodating development in surrounding areas. The 105,000 acres of Pine Barrens habitat is a diverse mosaic of pitch pine woodlands, pitch pine-oak forests, coastal plain ponds, swamps, marshes, grasslands, and streams. The Pine Barrens overlies Long Island's freshwater aquifer and helps to purify Long Island's drinking water. Water quality is threatened by land development above the aquifer. Contaminants including; household sewage, fertilizers, pesticides, farmland, golf courses, solid waste, various toxic chemicals, landfills, industrial wastewater and chemical wastes from laboratories, pet waste, and livestock manure all make way into the water supply.

In its upland areas, the Long Island Pine Barrens forests are often dominated by various species of oaks and pitch pine. The area is home to an array of unique vegetational communities; including the globally rare

dwarf pine plains that are characterized by a smaller variety of pitch pine; scrub-oak dominated shrublands where thickets of low-growing, bush-like trees can become virtually impassible; and herbaceous grasslands and meadows.

Much of the ecological community are adapted to and dependent on fire that releases nutrients, triggers germination of seedlings, and eliminates species competition. Numerous wetlands are found throughout the Long Island Pine Barrens including rare and unique coastal plain ponds whose surface water levels fluctuate with the water table and the shorelines of which is often home to a multitude of rare plants.

To create and maintain a thriving environment, the enhancement of existing habitat types is needed. A planting scheme that incorporates existing habitat types and introduces species that are typically found in the pine barrens ecosystem will be implemented as development progresses. Some species are already present on the site, other species will be brought in to enhance ecosystem services.

Trees

There are roughly 20 species of trees that are native to the Long Island Pine Barrens. Typically, the trees classified in this habitat type are tall, woody plants with a single stem (trunk).

- Atlantic White Cedar, *Chamaecyparis thyoides* –
- Black Jack Oak, *Quercus marilandica*
- Black Oak, *Quercus velutina* Lam.
- Gray Birch, *Betula populifolia*
- Pitch Pine, *Pinus rigida*
- Post Oak, *Quercus stellate*
- Red Maple, *Acer rubrum*
- Sassafras, *Sassafras albidum*
- Shortleaf Pine, *Pinus echinate*

- Smooth Alder, *Alnus serrulata*
- Sour Gum, *Nyssa sylvatica*
- Sweet Bay, *Magnolia virginiana*

Shrubs

There are about 68 species of shrubs native to the Long Island Pine Barrens. Any multi-stemmed perennial woody plants of low stature are classified as a shrub. Shrubs are one of the most abundant types of plant growth in the Long Island Pine Barrens and the defining characteristic of some of the vegetation communities. Listed below are the most common types of shrubs found within the Long Island Pine Barrens and that will be enhanced or introduced to the site.

- Black Huckleberry, *Gaylussacia baccata*
- Fetterbush, *Eubotrys racemose*
- Highbush Blueberry, *Vaccinium corymbosum*
- Inkberry, *Ilex glabra*
- Leatherleaf, *Chamaedaphne calyculata*
- Mountain Laurel, *Kalmia latifolia*
- Northern Bayberry, *Morella pensylvanica*
- Red Chokecherry, *Photinia pyrifolia*
- Shad-bush, *Amelanchier canadensis*
- Sheep Laurel, *Kalmia angustifolia*
- Swamp Azalea, *Rhododendron viscosum*
- Sweet Pepperbush, *Clethra alnifolia*

Herbaceous

There are over 250 native herbaceous plants in the Long Island Pine Barrens. There are annual, perennial, and biennial species present.

- Bog Asphodel, *Narthecium americanum*
- Frostweed, *Helianthemum canadense*
- Golden Hedge-hyssop, *Gratiola aurea*
- Golden-crest, *Lophiola aurea* Ker-Gawl
- New York Aster, *Aster novi-belgii*
- Pine Barren Gentian, *Gentiana autumnalis*
- Pitcher Plant, *Sarracenia purpurea*
- Round-leaf Sundew, *Drosera rotundifolia*
- Showy Aster, *Aster spectabilis*
- Star Flower, *Trientalis borealis*
- Swamp-pink, *Helonias bullata*
- Thread-leaf Sundew, *Drosera filiformis*
- Turkeybeard, *Xerophyllum asphodeloides*
- Turk's-cap Lily, *Lilium superbum*
- White Bonset, *Eupatorium album*
- Wild Lupine, *Lupinus perennis*

Aquatic Herbaceous

Several wetlands are located on site and aquatic plants play a key role in those ecosystem types. By enhancing aquatic ecosystems, endangered amphibians will be able to live and breathe successfully. The following plants are crucial to maintaining a healthy, wetland system.

- Arrow Arum, *Peltandra virginica*

- Goldenclub, *Orontium aquaticum*
- Horned Bladderwort, *Utricularia cornuta*
- Long-beaked Arrowhead, *Sagittaria engelmanniana*
- Oakes' Pondweed, *Potamogeton oakesianus*
- Pickerel Weed, *Pontederia cordata*
- Ten-angled Pipewort, *Eriocaulon decangulare*
- White Waterlily, *Nymphaea odorata* subsp. *odorata*

Ferns and Fern Allies

The Long Island Pine Barrens is not particularly rich in ferns, but there are a handful of predominant species that are present and enhance diversity in the sub-story ecosystem.

- Cinnamon Fern, *Osmunda cinnamomea*
- Climbing Fern, *Lygodium palmatum*
- Curly-grass Fern, *Schizaea pusilla* Pursh
- Foxtail Clubmoss, *Lycopodiella alopecuroides*
- Northeastern Bracken, *Pteridium aquilinum*
- Royal Fern, *Osmunda regalis*
- Slender Clubmoss, *Lycopodiella caroliniana*
- Virginia Chain Fern, *Woodwardia virginica*

Vines

There are about 16 vines that are native to the Long Island Pine Barrens. Some of the vines are classified as woody and others are classified as herbaceous.

- Compact Dodder, *Cuscuta compacta*

- Cranberry, *Vaccinium macrocarpon*
- Glaucus-leaved Greenbriar, *Smilax glauca*
- Hispid Swamp Blackberry, *Rubus hispidus*
- Summer Grape, *Vitis aestivalis*
- Walter's Greenbriar, *Smilax walteri*

Rushes and Sedges

Rushes and sedges are often confused with grasses. There are distinct characteristics such as flowers and fruit capsules that distinguish them from grasses. Rushes and sedges are evidence of wet soils and are found in wetlands and swamps. They help to filter pollutants from the soil and are used in maintaining soil stability.

- Bayonet Rush, *Juncus militaris*
- Pennsylvania Sedge, *Carex pensylvanica*

Orchids

Orchids add a special touch to the Long Island Pine Barrens. The intriguing plants offer season long interest with their intricate blossoms and variety of flowers.

- Arethusa, *Arethusa bulbosa*
- Crested Yellow Orchid, *Platanthera cristat*
- Grass Pink, *Calopogon tuberosus*
- Little Ladies'-tresses, *Spiranthes tuberosa*
- Nodding Ladies'-tresses, *Spiranthes cernua*
- Pink Ladies'-slipper, *Cypripedium acaule*
- Rose Pogonia, *Pogonia ophioglossoides*

- White Fringed Orchid, *Platanthera blephariglottis*
- Yellow Fringed Orchid, *Platanthera ciliaris*
- Yellow Fringeless Orchid, *Platanthera integra*

Grasses

The Long Island Pine Barrens is home to a unique variety of grasses that support a very diverse group of birds. The protected grasses spread over hundreds of acres and are critical in defining vegetation communities. There are over 50 species of grasses that are native to the Long Island Pine Barrens and they offer a rich diversity. The species below are the most commonly found and will enhance habitats on site.

- Blunt Manna Grass, *Glyceria obtuse*
- Giant Plume Grass, *Saccharum giganteum*
- Switchgrass, *Panicum virgatum*
- Pine Barren Reed Grass, *Calamovilfa brevipilis*
- Bushy Beard Grass, *Andropogon glomeratus*
- Little Bluestem, *Schizachyrium scoparium*
- Columbia Panic Grass, *Panicum columbianum*
- Pine Barren Smoke Grass, *Muhlenbergia torreyana*
- Pursh's Peanut Grass, *Amphicarpum purshii*

The implementation of plant materials, specifically trees, plays an important role when it comes to carbon sequestration within eco-industrial parks. A single tree can sequester CO₂ at a rate of 48lbs. per year and 1 ton of CO₂ within 40 years. A single acre of trees absorbs enough CO₂ in a year to eliminate a single car driving 26,000 miles and can minimize the carbon footprint of 18 average Americans.

With the goal of being 60% forested, approximately 1,500 acres and with an average of 30 trees per acre, 1,440,000 pounds of CO₂ will be sequestered by the trees in the eco-industrial park each year. These

numbers do not include the carbon that is sequestered by juvenile trees or herbaceous plant materials that grow on site.

The following figures show a series of images representing the plant palette of the pine barrens.

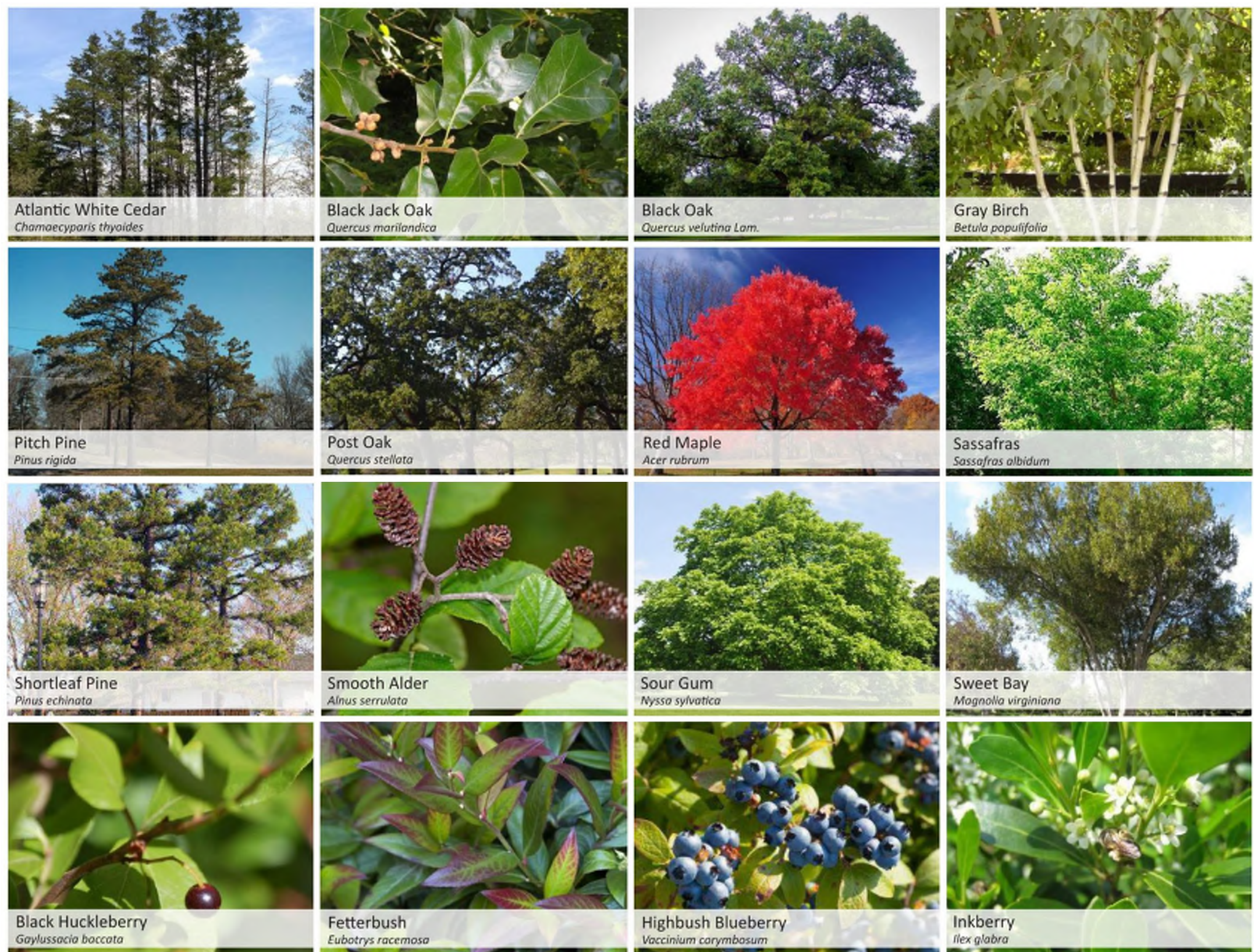


FIGURE 20: PINE BARRENS PLANT PALETTE



FIGURE 21: PINE BARRENS PLANT PALETTE

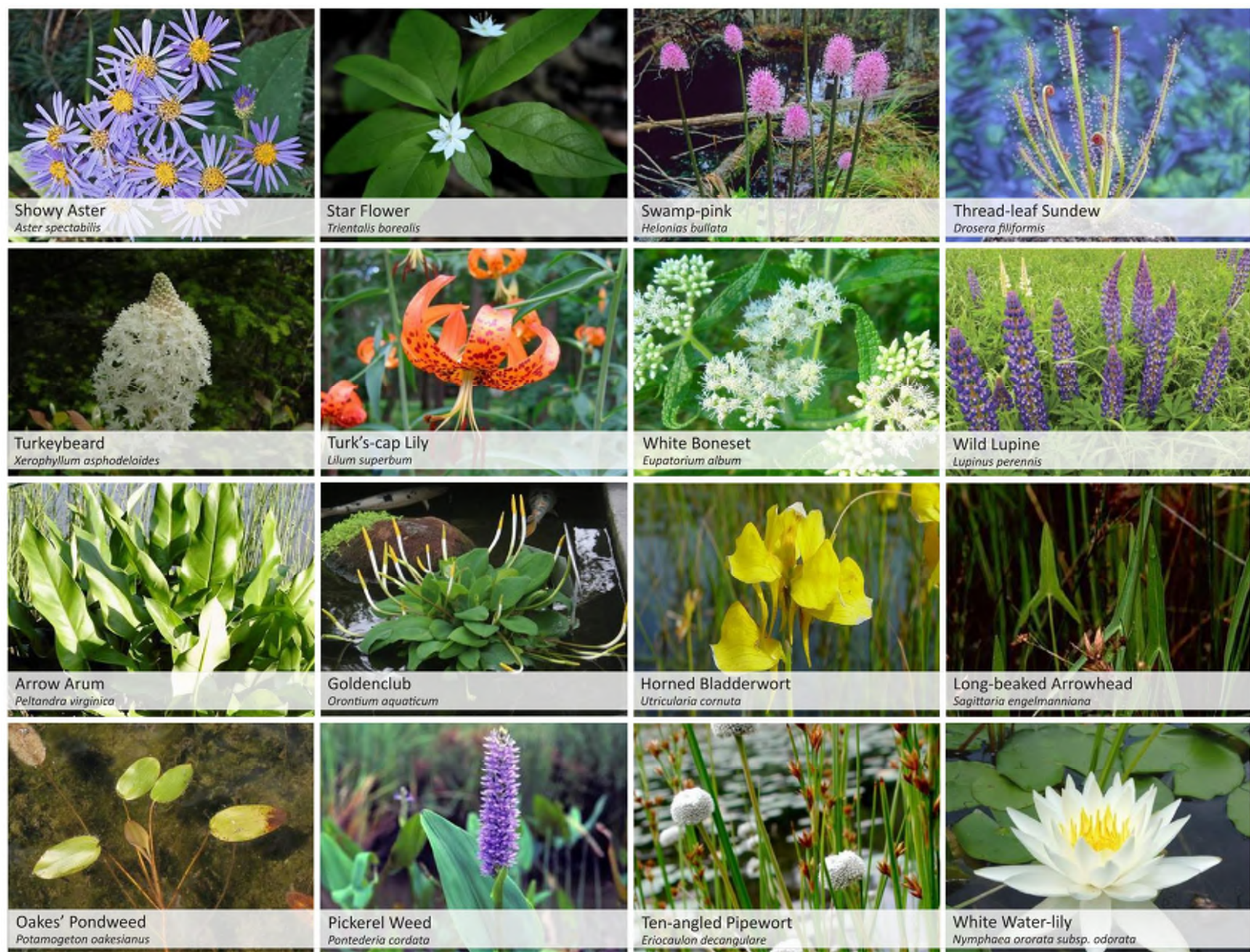


FIGURE 22: PINE BARRENS PLANT PALETTE



FIGURE 23: PINE BARRENS PLANT PALETTE

THE DESIGN PARAMETERS

Development and design decisions discover some of the unknowns of eco-industrial parks, reflect the goals that are outlined in the Calverton Enterprise Renewal Plan, and meet the requirements of the eco-industrial park design parameters. The design encompasses;

- All four of the ecosystem services – provisioning, regulating, supporting, and cultural
- Carbon sequestration through green building development and enhanced landscapes
- The sustainability of energy and fuel sources – example; the wood-based biorefinery uses wood matter to create fuel pellets for industrial size heating applications
- Minimizing the carbon footprint of the site through green transportation methods
- Co-generation between businesses
- Increase in taxable properties/businesses and increasing jobs in the community
- Increased productivity of employees through forest bathing
- Industrial land use in conformance with the Town of Riverhead’s master plan and amendments
- The best adaptive reuse of the site with the highest potential of economic development while preserving sensitive ecosystems
- The accommodation of regional influences and growth
- Development of industrial, commercial, and recreational land use that conforms with the land use policy of the Town of Riverhead
- The extension and improvements of infrastructure within the site, support the reuse of existing buildings, and improve and develop public facilities supporting the new land use

To minimize the environmental impact of the existing ecosystem and sensitive areas on site, the existing development areas were enhanced, and no new construction will take place exterior of either runway.

WHY A PROTOTYPE ECO-INDUSTRIAL PARK?

A prototype is the first model which others are developed or copied from. A wood-based biorefinery is a new, state-of-the-art process that needs to be implemented at full scale. The New Forest Economy Initiative creates the basis for the development of a wood-based biorefinery, an eco-industrial park gives it a physical place to be implemented. The process of a wood-based biorefinery is a new idea, an eco-industrial park will give it the ability and space to demonstrate its processes and further the research into by-product development.

Being the first eco-industrial park of its kind, the Enterprise Park at Calverton will serve as a prototype for similar developments in the future. This wood-based biorefinery powered eco-industrial park is designed in such a way that the design concept and parameters are easily transferable to the development of other eco-industrial parks. The parameters are grouped into specific categories but are general enough to leave designers enough room to design many possibilities while adhering to the guidelines.

Design parameters touch topics such as carbon sequestration, sustainability of energy and fuel sources, endangered species protection and net zero transportation methods; design aspects that are not just for the present, but for the future of the site.

The parameters are transferable and can be applied to both existing and future eco-industrial complexes, not only in New York State but any forested region in the United States and they touch on many of the current unknowns in eco-industrial park development. The design parameters are adaptable based on design and location opportunities.

The intentions of the New Forest Economy Initiative are to implement several wood-based biorefineries around New York State and potentially beyond. The Enterprise Park at Calverton will be the first test implementation, thus creating a prototypical model for other developments to follow. Although each site

will have different design constraints, the commonality will be that the wood-based biorefinery is the anchor element.

CONCLUSIONS

Through the use of design and design analysis, I have investigated the efficacy of using a wood-based biorefinery as an ecologically sound engine of industrial development in rural communities of New York State. The New Forest Economy Initiative brings together the energy technology of a state-of-the-art biorefinery with the older idea of an eco-industrial park and the intentions of providing a transferrable concept for rural industrial development – one that would work in any forested region of the United States.

After scaling the prototype to a full size biorefinery, 700 tons of wood matter could be processed daily. This biorefinery will be constructed at full scale after locational, architectural, landscape, and logistical implications have been tested. Being implemented in an eco-industrial park concept allows the biorefinery to be the anchor element that feeds a larger, cyclical system.

Creating a set of design standards to use in the development of eco-industrial parks answers a lot of the unknown questions that surround eco-industrial parks. Design teams, planning boards, facilities planners, and municipal offices now have a set of standards to reference that have specific requirements related to variables that include conservation, preservation, or enhancement of ecosystems.

VALUE(S) OF THE MODEL

The ecological, economic, social and aesthetic impacts of a wood-based biorefinery powered eco-industrial park adds value to neighboring properties and communities, ecosystems, and the overall well-being of the organisms that are directly and indirectly associated with it.

The design and implementation of a bio-refinery powered eco-industrial park at the Enterprise Park at Calverton will stand as a model and prototype for future eco-industrial park developments. The state-of-the-art project will showcase the most advanced technology to date while minimizing the on-site and contextual carbon footprint and contributing to the four categories of ecosystem services; supporting services, provisioning services, regulating services, and cultural services.

Supporting services will be used to maintain the conditions for human and eco-industrial activities. Through habitat restoration and unique maintenance practices, the ecosystems present on site will work to naturally recycle nutrients, produce and filter soil, maintain habitat quality, and encourage pollination so that ecosystems are able to provide and maintain a food and water supply. The eco-industrial framework mimics natural processes by recycling industrial waste and/or encouraging co-generation of excess energy between factories, maintaining habitat quality through the sequestration of carbon and recycling, and encouraging habitat succession within individual properties that contribute to the health of the greater ecosystem.

Provisioning services will be used to manage the material and energy outputs from the ecosystems and eco-industrial practices. The wood-based bio-refinery, the anchor element of the eco-industrial park, relies on hardwoods for its primary function of extracting liquid elements from woody materials. The majority of the wood needed to run the bio-refinery will be transported in from off-site but to help mitigate the shipping carbon footprint, willow biomass plantations will be planted, managed, and harvested throughout the eco-industrial park.

Regulating services will provide the benefits associated with the regulation of ecosystem processes such as climate regulation. With ecosystem enhancement, mature trees and vegetation provide natural climate regulation to both interior and exterior spaces. With strategic planting of trees adjacent to buildings, the

cost of heating and cooling buildings will decrease because the trees will block the sun during the warmer months and allow light through during the cooler months.

Cultural services are the non-material benefits that people obtain from ecosystems such as aesthetic inspiration, a sense of place, and spiritual experiences. With an aesthetically pleasing industrial complex and strategic planning of location and orientations of built forms, people are able to emotionally and spiritually engage themselves with the landscape and improve their piece of mind, work related productivity, and overall well-being.

ROLE(S) OF PARAMETERS

Design parameters serve as the foundation when developing an eco-industrial park. Parameters set a standard of quality that design teams should strive to achieve. The role of parameters ensures that each eco-industrial park is being developed from the same guidelines and they provide a structure for design teams to follow. These design parameters are created in such a way that they are transferable to a multitude of different types of sites and can still work towards the same goals of sustainability.

CHALLENGES: PARAMETERS IN THE DESIGN PROCESS

Design parameters were created in such a way that they are general and can be applied to different types of sites with varying design constraints. The challenge with this is that design parameters cannot be equally applied to every project. They can be received differently by the people interpreting them and results can vary depending on the site, location, goals and objectives, financing, etc.

NEXT STEPS

Where do we go from here? Professionals in design fields; architects, landscape architects, engineers, developers, and members of planning boards/committees need to see these ideas. These ideas will be

presented to rural planning committees and shown to various professionals who have the means to implement them in practice.

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EDUCATION

College of Environmental Science and Forestry (SUNY-ESF) | Syracuse, New York | May 2020
Master of Science Landscape Architecture
Thesis Topic: Using design and design analysis to create a prototypical design approach to industrial landscapes in New York State.
Bachelor of Landscape Architecture | May 2015
Semester Abroad: Cape Town, South Africa – Fall 2014
Morrisville State College | Morrisville, New York | May 2012
Associate of Applied Science in Landscape Architecture

WORK EXPERIENCE

Appel Osborne Landscape Architecture | Syracuse, New York | October 2018 – Present
Position: Project Designer
Responsibilities: Designing K-12 Capital Improvement Projects and drafting support
Carhartt | Syracuse, New York
Position: Supervisor
Responsibilities: Be an ambassador of the brand by providing advanced knowledge of world class customer service, product and company history, leadership skills, business practices, marketing and event outreach, and technology operations
Special Project(s): Actively serve as 1 of 13 Engagement Champions; a diverse and multi-faceted team selected from 5,400 employees from different sectors of the company who provide insight about the workplace
College of Environmental Science and Forestry | Syracuse, New York | January – May 2016
Position: Graduate Assistant
Responsibilities: Support a landscape architecture professor in the first-year masters studio by providing assistance with lesson plans, design software, portfolio building, studio sessions, and critiques
New York State Department of Environmental Conservation | May 2013 – August 2014
Position: Assistant Forest Ranger
Responsibilities: Patrol Zoar Valley Multiple Use Area in Gowanda, New York to ensure visitors were complying to rules and regulations, record daily activities and incidents, practice wilderness first aid and rescue practices as needed
Josh Lawn Care & Landscaping | Honeoye-Falls Lima, New York | May – August 2012
Position: Landscape Design Intern
Responsibilities: Assist in residential landscape design and consultations and learning and becoming proficient in the company's landscape design software

AWARDS AND RECOGNITION

2016 | Sigma Lambda Alpha Honor Society Lifetime Member
2014 | Men's Garden Club of Syracuse Scholarship Recipient
2010 | Livingston County Chamber of Commerce Scholarship Recipient